Journal of International Food & Agribusiness Marketing

ISSN: 0897-4438 (Print) 1528-6983 (Online) Journal homepage: https://www.tandfonline.com/loi/wifa20

Big Data and Dietary Trend: The Case of Avocado Imports in China

Bo Xiong & Yuhe Song

To cite this article: Bo Xiong & Yuhe Song (2018) Big Data and Dietary Trend: The Case of Avocado Imports in China, Journal of International Food & Agribusiness Marketing, 30:4, 343-354, DOI: 10.1080/08974438.2018.1426073

To link to this article: https://doi.org/10.1080/08974438.2018.1426073

Published online: 07 Feb 2018.

JOURNAL OF INTERNATIONAL FOOD & AGRIBUSINESS MARKETING
2018, VOL. 30, NO. 4, 343–354
https://doi.org/10.1080/08974438.2018.1426073

Check for updates

Big Data and Dietary Trend: The Case of Avocado Imports in China

Bo Xiong[a] and Yuhe Song[b]

[a]Data Mining Specialist for Southern California Edison, Irwindale, CA, USA; [b]Foreign Economic Cooperation Center, Ministry of Agriculture, Beijing, P.R. China

ABSTRACT
The advancement of data science and technology presents a unique opportunity to understand rapidly evolving dietary trend around the world. In this case study, we show that the Baidu index, a measurement of the intensity of user searches for specific words, helps explain and forecast the growth of avocado imports in China. Specifically, we find that China's avocado imports rise by 8% in response to a 10% increase in the Baidu index. Furthermore, the inclusion of the Baidu index in a standard demand model reduces the prediction error by 2.7%.

KEYWORDS
Avocado; Baidu index; big data; China; cross validation

Introduction

The estimation and forecast of food demand are critical to agribusiness marketing. Conventional analyses of food demand tend to focus on market conditions, such as price and income levels, demographical characteristics that indirectly capture different preferences cross different consumer groups, and survey-based responses that directly reflect the preferences of consumers. For example, Huang (1985) and Park, Holcomb, Raper, and Capps (1996) focused on the price and income effects on food demand in the United States. Lin, Guenthner, and Levi (1992) investigated Japan's potato imports and found that the prices of complement products significantly affect the demand for potatoes. In a case study of beef consumption, Acebrón and Dopico (2000) showed that consumers' valuations of the intrinsic attributes play a significant role as well. Orth and Firbasová (2003) further illustrated that cultural or ethnical origins of products can be important drivers of demand. Grunert (2005) found that consumers' perception of food safety risks is also a key determinant of food demand. However, the conventional approaches to food demand fall short when the products of interest are novel items for which most consumers are in the progress of developing their preferences.

The analysis of consumer demand for a novel food product requires a measurement of consumer preferences that reflects consumers' involving

CONTACT Dr. Yuhe Song songyuhe_6387@sina.com Foreign Economic Cooperation Center, Ministry of Agriculture, Beijing 100125, P.R. China.
Color versions of one or more of the figures in the article can be found online at www.tandfonline.com/wifa.

interest in the product on the one hand and is readily observable by researchers on the other. In this article, we propose the deployment of online search intensity indices as the alternative measurements of consumer preferences for novel food items. In particular, online search intensity indices have two major advantages in measuring consumer preferences. First, as a tool for information acquisition, online search is likely to precede actual transactions in the marketplace. This forward-looking feature of online search is particularly useful in predictive analyses of food demand. Second, online searches are initiated by users themselves. In other words, the measurement does not suffer from either the bias of survey designers or untruthful responses from survey subjects. In the remainder of the article, we use the case study of China's avocado imports to illustrate how online search intensity indices help us better explain and forecast consumer demand for novel food products.

Figure 1 displays China's monthly imports of avocados from October 2012 to October 2016. Prior to 2011, avocado imports in China were virtually nonexistent. In a short five-year period, China's avocado imports have reached more than $60 million a year.

What explains the significant growth of avocado imports in China? The standard economic theory points to two potential factors: the fast growth of China's overall economy and the evolvement of avocado prices. However, as we show later, the two economic factors cannot fully account for China's rising demand for avocados. In fact, we stipulate that another key driver is the change in preferences of Chinese consumers and the affluent urban citizens in particular. Specifically, we use the Baidu index to characterize the changing preferences in China and incorporate the index into China's avocado demand model. The empirical results suggest that China's avocado imports rise by 8% in response to a 10% increase in the Baidu index.

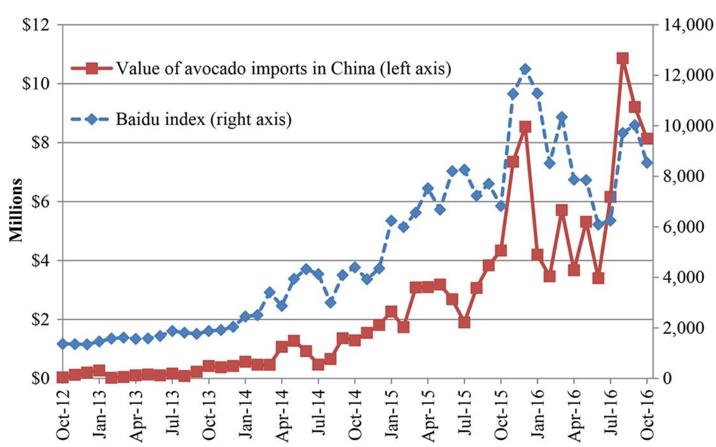

Figure 1. China's monthly imports of avocados and Baidu index. Data sources: China's import values of avocados (product code 080400) are extracted from TRADEMAP. The monthly Baidu index is derived from the weekly indices available from Baidu.

Furthermore, the inclusion of the Baidu index in the import demand model reduces the prediction error by 2.7%.

The remainder of the article is organized as follows. In "Application of data science in agricultural economics" section, we first review the application of data science in agricultural economics and then introduce the Baidu index and related metrics. In "A case study of China' imports of avocados" section, we empirically estimate China's imports of avocados to illustrate the usefulness of big data metrics in explaining and forecasting food demand. "Conclusion" section concludes the article by drawing policy implications for stakeholders in international agribusiness and food sectors.

Application of data science in agricultural economics

Emergence of data science in agricultural economics

The advancement of data science and technology has the potential to benefit all disciplines including agricultural economics.[1] In January 2016, the United States Congressional Research Service released a report that summarizes the opportunities and challenges in applying data science and technology in the agricultural and food sectors (Stubbs, 2016). The Council on Food, Agricultural, and Resource Economics is also in partnership with land-grant research universities to investigate the impact of big data on U.S. agricultural competiveness.[2]

Nevertheless, most efforts have been put on the production side of food and agriculture. That is, the research objectives primarily focus on how to utilize big data to improve the efficiency of farm management and food production. The application of big data on the consumption side of food and agriculture is quite limited to date. (Kaabia, Angulo, & Gil, 2001) find that health information promotes Spain's consumption of fish and poultry and lowers its demand for beef and pork. (Piggott & Marsh, 2004) show that U.S consumers modestly respond to food safety information about meat products. More recently, (Yadavalli & Jones, 2014) find that media coverage of lean finely textured beef has transitory impact on consumer demand for beef products. In addition, (Xiong, Sumner, & Matthews, 2014) show that media coverage of the health effects of olive oil is a robust driver of olive oil demand in the United States. However, few articles go beyond traditional media outlets and utilize user-generated metrics on the Internet.[3] Our article expands the literature by deploying big data metrics to better understand food consumption and consumer behavior.

Introduction of Baidu index and other big data metrics

The Baidu index essentially measures the intensity of users' search for a specific word on Baidu, which is the dominant search engine in mainland

Table 1. Frequently asked questions about "avocado" in Baidu knowledge.

Rank	Question
1	"How to eat an avocado?"
2	"How does an avocado taste?"
3	"How to best serve avocados?"
4	"What are the health benefits of avocados?"
5	"Who should avoid avocados?"

Note: The table is authors' translation from the statistics available from the Baidu Knowledge in the week of February 6, 2017.

China. Specifically, the Baidu index takes into account the number of times the keyword appears in user-provided phrases or sentences and the relative importance of the keyword in users' queries. For instance, Figure 1 displays the Baidu index for "avocado" from October 2012 to October 2016. As shown in Figure 1, the Baidu index for "avocado" is highly correlated with China's imports of avocados. The popularity of online searches for avocados in China is partially attributable to the promotion of the health benefits of avocadoes worldwide. Therefore, we later deploy an econometric model to test the hypothesis that the evolving preferences in China, as approximated by the Baidu index, contribute significantly to China's growing demand for avocados.

In addition to the Baidu indices, other qualitative information also sheds light on Chinese consumers' appetite and interest in avocadoes. For example, Table 1 shows the top five frequently asked questions about avocados in the Baidu Knowledge platform.[4] The first three questions are presumably from

Figure 2. Geographical distribution of online searches for "avocado". *Note*: The figure is based on search records in Baidu from September 2013 to October 2016. Geographical distribution of searches prior to September 2013 is not publicly available.

Chinese consumers who have not had avocados before but consider trying. This indicates that the Chinese market bears huge potential for avocado growers and exporters. The fourth question in Table 1 is specifically about the health aspects of avocados, which suggests that healthiness is indeed important to consumers.

Figure 2 displays the geographical distribution of user searches for "avocados" in the past 3 years. It appears that Chinese citizens in metropolitan cities and coastal provinces show most interest in avocados, probably because this population is relatively wealthier and better informed. The geographical disparity further demonstrates the large room for growth of the avocado market in China.

A case study of China' imports of avocados

The production, trade, and characteristics of avocados

The world production of avocados reached 5 million tons in 2013.[5] Mexico, Dominican Republic, and Peru are the major producing nations. Specifically, the outputs from Mexico, Dominican Republic, and Peru account for 30, 8, and 7%, respectively, of the world total production.

International trade of avocados reached 1.2 million tons in 2013. Not surprisingly, Mexico is the dominant exporter in the world market, contributing to 46% of global avocado trade. Peru and Chile have also expanded their oversea sales in recent years. On the importing side, the largest market is the United States, which imports nearly 44% of all traded avocados. Netherland and France are major destination markets as well, together absorbing 20% of avocado imports. Despite its rapid growth, as shown in Figure 1, China's market for avocados remains tiny from the perspective of the world market.

Avocado as a food product has several desirable characteristics. For example, avocados are rich in vegetable fat, potassium, and vitamin K. More recently, various health benefits of avocados have been discovered or confirmed by the scientific community.[6] For instance, the regular consumption of avocadoes is found to be associated with fewer symptoms of arthritis, lower levels of cholesterol, and reduced likelihood of liver diseases. As a result, marketing agencies around the world have made great efforts to promote and publicize the healthiness of avocados.[7]

Econometric analysis

In this section, we propose an econometric model to characterize China's imports of avocados. The model is novel in two aspects. First, we include the Baidu index as a demand determinant to capture the changes in preferences of Chinese consumers. Second, we apply a cross validation method to verify the predictive power of the model so that peer researchers and practitioners can use the model to forecast the growth of China's avocado imports.

The model specification and data sources

We characterize China's import demand for avocados with three major determinants. First, we take into account China's economic growth. The underlying hypothesis is that China's demand for avocados rises as the economy continues to grow. A better measurement might be the income level of Chinese residents in metropolitan cities and coastal provinces (recall Figure 2). However, the income data for that particular population is unavailable.

Second, we include the world price of avocados as another demand driver. We expect China's avocado imports to be inversely associated with the avocado price. It is worth noting that the avocado price can be seen as exogenous to the Chinese market because China's domestic production and consumption of avocados remain small relative to the world avocado market.

Most importantly, we incorporate the Baidu index, shown in Figure 1, as another demand factor to capture Chinese consumers' evolving interest in avocados. In the next section, we test the hypothesis that the Baidu index is a significant predictor of China's avocado imports, even when the income and price effects are properly controlled for.

Specifically, the econometric model takes the following form:

$$\ln(q_t) = \beta_0 + \beta_1 \ln(y_t) + \beta_2 \ln(p_t) + \beta_3 \ln(b_t) + \varepsilon_t, \quad (1)$$

where the variable q_t is China's import quantity of avocados in time t, the variable y_t is China's GDP in time t, the variable p_t is China's import price of avocados in time t, the variable b_t is the Baidu index for "avocado" in time t, and ε_t is the error term. The β_s are the parameters to be estimated. Note that we work with all variables in the logarithmic scale so that the estimated parameters can be directly interpreted as elasticities. In the next section, we estimate Equation (1) via the least square procedure after attending to the potential time-series issues with monthly data.

The econometric model in Equation (1) serves two purposes. First, we can make causal inferences after estimating the parameters. In Section 6.2, for example, we answer the question what happens to avocado imports in China if the search intensity rises. Second, we can forecast China's avocado imports with the fitted model and a known set of demand determinants. To accomplish this task, we ought to evaluate the predictive accuracy of the model. Therefore, we introduce the cross validation method, which is commonly used in predictive modeling.

For prediction purposes, some researchers are inclined to estimate Equation (1) with the full sample and compare the predicted outcomes with the actual outcomes. The problem with this method is that it fails to measure the predictive accuracy of the model when a different sample is drawn from the population. One possible solution is the cross validation method. That is, we split the full sample into two subsets: one subset for the estimation of parameters and the other subset for the comparison of predictions actual outcomes. In the field of predictive modeling, the former subset is called the training data, and the latter subset is referred to as the test data. Intuitively, the cross validation method leaves out some observations when fitting the model so that one can evaluate the accuracy of the out-of-sample predictions.

One caveat with the cross validation method is that the result can be sensitive to how the original sample is split. An enhanced approach is the *K*-fold cross validation. The idea is to split the sample into *K* subsets of comparable sizes and conduct cross validation for *K* times. In each cross validation, one of the *K* subsets is held out as the test data and the rest of the observations are used as the training data. The final predictive accuracy is the average predictive accuracy over the *K* experiments.[8] In Section 6.3, we conduct the fivefold cross validation based on the econometric model specified by Equation (1).

Data other than the Baidu index are extracted from multiple sources. Specifically, we extract China's monthly import values and quantities of avocados from the TRADEMAP database from October 2012 to October 2016.[9] We then derive the unit-value of avocado imports in China and use it as the measurement of avocado price faced by China. Figure 3 displays the movements of China's import price of avocados. As shown in Figure 3, the avocado price has increased to more than \$3/kg in 2016. The swings in prices are largely driven by seasonal factors in Central and South Americas.

Next, we attend to China's GDP data. China's seasonally adjusted GDP growth rates by quarter are available from the national account website of the Organization for Economic Cooperation and Development.[10] To derive

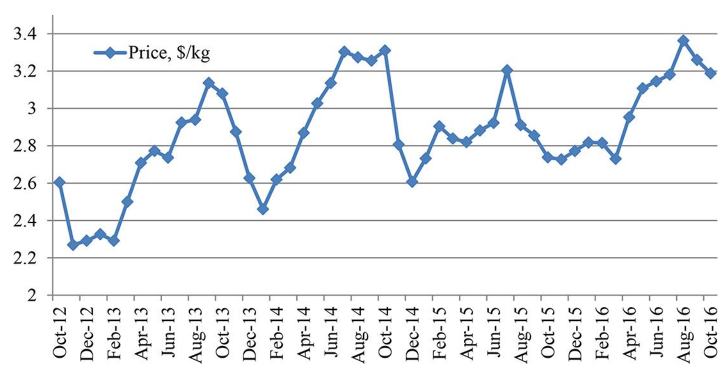

Figure 3. China's import price of avocados, October 2012–October 2016. *Note*: Authors' calculation of unit values based on China' import values and quantities of avocados. Data source is TRADEMAP.

Table 2. The tests for unit root and serial correlations of China's import quantity.

Type of test	Null hypothesis	Test statistic	*P*-value
Dickey–Fuller test for unit root, with time trend	Import quantity contains a unit root	−4.401	0.002
Durbin's test for autocorrelation	Import quantity is not auto-correlated	3.796	0.058

the monthly GDP growth rates in China, we use the piecewise polynomial method to smooth the quarterly series into the monthly counterparts.

The empirical results and discussions

Since we work with monthly import data, we first check for potential problems of unit roots and serial correlations. Specifically, we conduct the Dickey–Fuller test for unit root with a time trend. The null hypothesis is that China's avocado import quantities contain a unit root. The test result in Table 2 suggests that China's import quantity of avocados does not contain a unit root. Therefore, we can estimate Equation (1) in its original specification as opposed to in the first-order differenced form.

We also address the serial correlation problem with the monthly import data. In particular, we conduct the Durbin's test for autocorrelation in which all independent variables are considered exogenous. The test result in Table 2 indicates that China's avocado import exhibits mild autocorrelations over time. Specifically, the absence of serial correlation is rejected at the 10% significance level but not rejected at the 5% level. To correct for the autocorrelations, we construct the standard errors of the estimated parameters in Equation (1) using the robust estimates of the variance–covariance matrix.

We estimate Equation (1) through the ordinary least square and construct robust standard errors for statistical inferences. Table 3 shows the estimation results. We find that China's economic growth contributes significantly to its rising imports of avocados. The estimated elasticity is fairly large (more than 11) probably because the overall economic growth does not fully reflect the rising income levels of avocado consumers in China. Recall that most avocado consumers are likely to reside in metropolitan cities or coastal provinces (Figure 2). If the income growth rate of these consumers is three times of the GDP growth rate, then the actual income elasticity of avocado demand is approximately $11/3 = 3.7$.

Table 3. The estimation results for China's monthly imports of avocados.

Variable	Coefficient	Robust standard error	*P*-value
Log of China's GDP	11.67***	2.227	0.000
Log of avocado price	−1.274	1.128	0.265
Log of Baidu index	0.848***	0.243	0.001
Constant	−10.40*	6.063	0.093
R^2	0.905	Sample size	49

Note: The notations *, **, and *** refer to significance levels of 10, 5, and 1% respectively.

As shown in Table 3, the avocado price is inversely associated with China's avocado imports. Specifically, the price elasticity is estimated to be around −1.3, which means that 10% decrease in the avocado price would boost China's avocado imports by 13%. Nevertheless, the price effect is not statistically significant, possibly due to the small size of the sample.

More importantly, we find from Table 3 that the Baidu index for "avocado" is a significant driver of China's avocado imports. In particular, the estimated elasticity suggests that a 10% increase in consumers' search intensity for avocados would expand China's avocado imports by nearly 8.5%. The finding lends support to the hypothesis that the changing preferences of Chinese consumers contribute substantially to the rising demand for avocados in China. Overall, the three demand determinants explain over 90% of the variations in avocado imports in China.

Now we investigate the predictive power of the econometric model. As discussed in Section 5.2, we implement the fivefold cross validation method to evaluate the predictive accuracy, which is measured by the mean squared error of the predicted outcomes. In particular, we consider three model specifications. The first specification only includes a constant term as the independent variable. That is, we evaluate the predictive accuracy without any informative determinants. The second specification includes all independent variables except for the Baidu index. In other words, we assess the predictive power without resorting to big data metrics. The third specification includes all independent variables as dictated by Equation (1). We expect the prediction error to decrease as we fit the three models in sequence. Table 4 displays the 5-fold cross validation results.

As shown in Table 4, the inclusion of price and GDP as independent variables reduces the prediction error from 2.548 to 0.293, or 88.5%. This indicates that standard economic factors go a long way toward explaining and forecasting food demand. Furthermore, the incorporation of the Baidu index further reduces the prediction error to 0.285, or a 2.7% improvement upon the standard economic model. The finding suggests that the Baidu index, as a measurement of consumer appetite and interest, is useful in explaining as well as forecasting China's avocado imports.

A sensitivity analysis: Is the Baidu index endogenous?

One legitimate concern is that the Baidu index might be endogenous in the import demand model. That is, consumers' search intensity for avocados in

Table 4. Fivefold cross validation results for China's avocado imports.

Specification	Independent variables	Mean square error
1	Intercept only	2.548
2	Intercept, price, and GDP	0.293
3	Intercept, price, GDP, and Baidu index	0.285

part depends on the availability of avocados in the marketplace. In other words, the Baidu index and China's avocado imports could be reinforcing each other.

To address this potential issue, we test the exogeneity of the Baidu index for "avocado" with an instrument variable: the Baidu index for "mango." The underlying assumption is that consumers' preferences for the two tropical fruits are correlated but the Baidu index for "mango" bears no further information about China's avocado imports. Figure A in Appendix A displays the monthly variations of the Baidu index for "mango." It appears that Chinese consumers' interest in mango has risen substantially from late 2012 to early 2015 but subsequently declined to a certain extent.

With this instrument variable, we use the Hausman-Durbin-Wu test to verify the exogeneity of the Baidu index for "avocado" in the econometric model specified in Equation (1). The test result, available in Table B of Appendix B, fails to reject the null hypothesis that the Baidu index for "avocado" is an exogenous factor that drives the rising avocado imports in China.

Conclusion

The advancement of data science and technology presents a unique opportunity to understand rapidly evolving dietary habits around the world. When consumers are in the process of acquiring information and developing preferences for novel products, conventional economic and demographical measurements fail to capture the changing preferences and the resulting behavior. In this article, we demonstrate that metrics based on user searches via online engines fill the gap by providing a concurrent indicator of consumer interest.

Specifically, we provide a case study of China's avocado imports to illustrate the usefulness of these big data metrics in deepening our understanding of food demand. We find that the Baidu index, a measurement of the intensity of user searches for specific words, helps explain and forecast the growth of avocado imports in China. In particular, our estimate suggests that China's avocado imports rise by 8% in response to a 10% increase in the Baidu index. Furthermore, we demonstrate that the inclusion of the Baidu index in the standard food demand model reduces the prediction error of the model by 2.7%.

The empirical findings are particularly relevant to agribusiness stakeholders who grow or market food products featuring health concepts. First, health benefits appear to enhance product demand when the claims are based on scientific evidence. Second, the cultivation of consumer interest might prove a highly effective marketing strategy. Finally, user-generated data in the cyber space are remarkably informative and potentially valuable to food producers, wholesalers, and retailers.

Notes

1. See Varian (2014) for a review of the application of big data in economics in general.
2. A policy briefing is available from C-FARE at http://www.cfare.org/UserFiles/file/10-7-2016BigData_v1.pdf.
3. See Lusk (2016) for a recent attempt to apply big data methods to food demand surveys.
4. The Baidu Knowledge is a platform where users ask and answer questions.
5. The production and trade data in this section are from the FAOSTAT databank, Food and Agriculture Organization. http://www.fao.org/faostat/en/.
6. A summary of the various benefits of avocados and the supporting evidence is available from http://www.well-beingsecrets.com/health-benefits-of-avocado/.
7. On January 31, 2015, for instance, *The Atlantic* reviews how avocado has gone from obscure delicacy to America's favorite fruit. The full article is available from http://www.theatlantic.com/health/archive/2015/01/the-selling-of-the-avocado/385047/.
8. Interested readers are referred to James, Witten, Hastie, and Tibshirani (2013) for an introduction of predictive modeling methods.
9. The database is accessible at http://www.trademap.org/.
10. The website can be accessed from http://stats.oecd.org/index.aspx?queryid=350.

References

Acebrón, L. B., & Dopico, D. C. (2000). The importance of intrinsic and extrinsic cues to expected and experienced quality: An empirical application for beef. *Food Quality and Preference*, *11*(3), 229–238. doi:10.1016/s0950-3293(99)00059-2

Grunert, K. G. (2005). Food quality and safety: Consumer perception and demand. *European Review of Agricultural Economics*, *32*(3), 369–391. doi:10.1093/eurrag/jbi011

Huang, K. S. (1985). *US demand for food: A complete system of price and income effects* (No. 1714). US Dept. of Agriculture, Economic Research Service. Washington, D.C.

James, G., Witten, D., Hastie, T., & Tibshirani, R. (2013). *An introduction to statistical learning* (Vol. 6, pp. 176–182). New York: Springer.

Kaabia, M. B., Angulo, A. M., & Gil, J. M. (2001). Health information and the demand for meat in Spain. *European Review of Agricultural Economics*, *28*(4), 499–517. doi:10.1093/erae/28.4.499

Lin, B. H., Guenthner, J. F., & Levi, A. E. (1992). Forecasting Japan's frozen potato imports. *Journal of International Food & Agribusiness Marketing*, *3*(4), 55–67. doi:10.1300/j047v03n04_05

Lusk, J. (2016). *Consumer research with big data: Applications from the Food Demand Survey*. http://static1.squarespace.com/static/502c267524aca01df475f9ec/t/57a1d4c1e6-f2e155f6e8eff9/1470223591019/pres+address+2.pdf

Orth, U. R., & Firbasová, Z. (2003). The role of consumer ethnocentrism in food product evaluation. *Agribusiness*, *19*(2), 137–153. doi:10.1002/agr.10051

Park, J. L., Holcomb, R. B., Raper, K. C., & Capps, Jr. O. (1996). A demand systems analysis of food commodities by US households segmented by income. *American Journal of Agricultural Economics*, *78*(2), 290–300. doi:10.2307/1243703

Piggott, N. E., & Marsh, T. L. (2004). Does food safety information impact US meat demand? *American Journal of Agricultural Economics*, *86*(1), 154–174. doi:10.1111/j.0092-5853.2004.00569.x

Stubbs, M. (2016). *Big data in U.S. agriculture* (7–5700), Congressional Research Service. Washington, D.C. Available at http://fas.org/sgp/crs/misc/R44331.pdf

Varian, H. R. (2014). Big data: New tricks for econometrics. *The Journal of Economic Perspectives*, *28*(2), 3–27. doi:10.1257/jep.28.2.3

Xiong, B., Sumner, D., & Matthews, W. (2014). A new market for an old food: The US demand for olive oil. *Agricultural Economics*, *45*(S1), 107–118. doi:10.1111/agec.12133

Yadavalli, A., & Jones, K. (2014). Does media influence consumer demand? The case of lean finely textured beef in the United States. *Food Policy*, *49*, 219–227. doi:10.1016/j.foodpol.2014.08.002

Appendix A. The Baidu index for "mango"

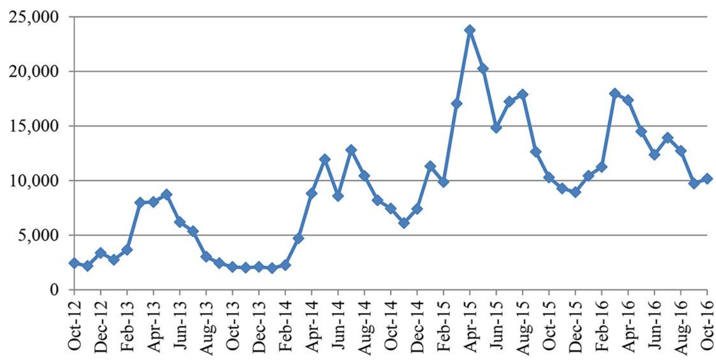

Figure A. The Baidu index for "mango" from October 2012 to October 2016. Data source: The monthly Baidu index for "mango" is derived from the weekly indices available from Baidu.

Appendix B. The test of exogeneity of the Baidu index for "avocado"

Table B. The Hausman–Durbin–Wu test result for the Baidu index for "avocado."

Step 1: Modeling Baidu index for "avocado" with all exogenous variables			
Variable	*Coefficient*	*Standard error*	*P value*
Log of China's GDP	7.470***	0.526	0.000
Log of avocado price	−0.717**	0.341	0.041
Log of Baidu index for "mango"	**0.191*** **	**0.057**	**0.002**
Constant	1282	2.140	0.552
R^2	0.930	Sample size	49
Step 2: Modeling China's avocado imports with the additional residual term			
Variable	*Coefficient*	*Standard error*	*P value*
Log of China's GDP	20.43***	6.541	0.003
Log of avocado price	−1.859*	0.957	0.059
Log of Baidu index for "avocado"	−0.173	0.753	0.819
Residual term from Step 1	**1.277**	**0.842**	**0.137**
Constant	−6.653	5.798	0.257
R^2	0.909	Sample size	49

Note: The notations *, **, and *** refer to significance levels of 10, 5, and 1%, respectively.