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Journal of Agricultural and Applied Economics, 41,2(August 2009):493–500
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The Food versus Fuel Debate: Implications for Consumers

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The effects of biofuel production on commodity prices and their transmission to retail food prices are discussed. Factors driving higher commodity prices are tight global supplies and increased demand of corn ethanol in the short term. Evidence suggests that higher corn prices contribute to food price inflation for some food items. These include eggs, poultry, pork, beef and milk. The findings imply that food price inflation for these items is related to increased production of corn ethanol, primarily because of high oil prices. Higher oil prices also increase fuel and energy costs, which increase marketing costs for all food categories.

Key Words: Biofuels, food prices, ethanol

JEL Classifications: Q420, Q130

Perhaps for the first time in history the general public has become aware that fuel has joined food, fiber and feed as an agricultural output. Consider what we have witnessed in recent years. In 2007, U.S. farmers planted 93.6 million acres of corn, the largest planting since 1944. Domestic corn use is estimated to be a record 10.6 billion bushels for 2007/08 with ethanol accounting for 24% of the total (Glauber, 2008). The US produced about 6.2 billion gallons of corn-based ethanol in 2007, and the Energy Independence and Security Act of 2007 (EISA) calls for 36 billion gallons of renewable transportation fuels by 2022. Of that quantity, 16 billion gallons must be produced from cellulosic feedstocks, and corn-based ethanol is capped at 15 billion gallons.

Food and energy prices reached historic highs in 2008. Oil prices reached $147 per barrel and national averages for gasoline reached $4.00 per gallon. High energy prices provide incentives for policies that strive for energy independence and continued support for subsidies and tax credits to support ethanol production. In addition to high energy prices, farm-level prices for corn averaged a record $4.10–4.50 per bushel for 2007/08, and are expected to remain high for the 2008/09 crop year (Glauber, 2008). Farm prices for other grains are also at historic highs. Moreover, the U.S. consumer prices index (CPI) for food increased by 5.2% in September of 2008, the largest annual increase in retail food prices since 1990 (Glauber, 2008). This has led to assertions that utilizing corn as a feedstock for ethanol is an important determinant for high grain prices, and subsequently high food prices.

Although corn-based ethanol may contribute to higher prices for corn, and perhaps indirectly for other feed grains, other factors play a role. Higher energy costs, tight global grain supplies, strong export demand, and rapidly growing Asian economies are often overlooked in the public debate regarding the effects of

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ethanol (and biodiesel) on commodity prices. Moreover, the transmission of farm-level commodity prices to retail food prices has not been given enough attention in this discussion. This paper discusses the effects of biofuel production on corn and other commodity prices, and the transmission of higher commodity prices on retail food prices. Recent trends in commodity and retail food price inflation are presented, and linkages between biofuels, farm-level prices, and retail food prices are discussed.

Linkages between Biofuels and Commodity Prices

Prices for farm commodities are historically volatile, but for many commodities prices in 2007/08 were near record levels. The reasons for this have been attributed to many factors, including global changes in agricultural production and food consumption – primarily growth in food demand and shifts in dietary preferences for more animal protein in China and India; weather and crop diseases in 2006/07; lower investment in agricultural research; higher production costs primarily related to oil (i.e., fertilizer and diesel costs); speculation in commodity markets; depreciation of the U.S. dollar; and the diversion of corn and vegetable oils from food and feed use to feedstock for biofuels production (Abbot, Hurt, and Tyner, 2008; Trostle, 2008). Although all of these factors have a role in determining commodity prices, the focus of this paper will be on the role of biofuels in determining corn and other commodity prices and how these prices affect retail food prices.

The world biofuels industry is composed of ethanol and biodiesel production. In 2007 world production of ethanol and biodiesel was approximately 12.9 and 2.3 billion gallons, respectively. The United States and Brazil are the largest producers of ethanol with each country accounting for approximately 37% of the total. The United States produces approximately 22% of total biodiesel with the European Union producing approximately 76% (USDA/ERS). Corn is the primary grain used for ethanol production in the United States, whereas sugar cane is the primary feedstock used for ethanol in Brazil. Soybean oil is the primary feedstock for biodiesel production in the U.S. and rapeseed oil is the EU's primary feedstock for biodiesel (Trostle, 2008).

Linkages between Oil and the Demand for Biofuels

It is important to understand the link between oil prices, the demand for ethanol, and the price of corn. When oil prices are high relative to corn prices it becomes more profitable to produce ethanol. This is because higher oil prices raise the cost of producing gasoline. As gasoline becomes more expensive relative to ethanol, refineries increase their output of gasoline/ethanol fuels such as E-10 and E-85. This results in an increase in demand for ethanol and a subsequent increase in its price. Increasing oil prices since 2005 and through much of 2008, as well as favorable public policies aimed at increasing biofuel production, have led to favorable conditions for expansion of the biofuels industry in the last five years. There is a similar relationship between the price of oil and feedstocks used to produce biodiesel.

Demand for Ethanol and Corn Prices

The following discussion utilizes production, supply, and distribution data provided by the United States Department of Agriculture Foreign Agricultural Service for the years 1961–2008. World production of corn has trended up since the early 1960s, increasing by 24.5% in the last five years (Figure 1). Total corn usage, which is comprised of corn used for feed and corn used for food, seed, and industrial (FSI) products, has also trended up since the early 1960s (Figure 2). There has been long run growth for both feed and FSI, but greater long term growth for feed relative to FSI since 1961. However, since 2004, growth in FSI (which includes feedstocks for corn ethanol) has increased by an average of 9.6% per year, whereas corn used for feed has increased by only 0.73% per year. The growth in total corn usage since 2004 has been comprised of 64 million metric tons for FSI and 34 million metric tons for feed, which represents a 65% growth in FSI as

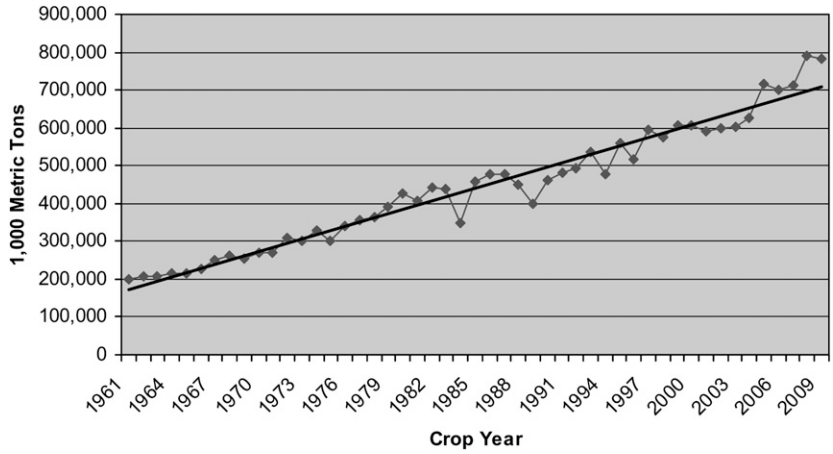

Figure 1. World Corn Production (Source: USDA Foreign Agricultural Service, Production, Supply, and Distribution Data, Sept. 2008)

compared with 35% for feed over the last four years (Abbott, Hurt, and Tyner, 2008).

The above-mentioned production and usage data reveal both long and short term changes in supply and demand conditions for corn. Stocks-to-use ratios are useful indicators of relative supply and demand conditions. Calculated as the ratio of ending stocks to total consumption for a given crop year, they measure the percentage of carryover stocks available to meet demand during the next crop year. The stocks-to-use ratio for corn has fallen from a high of 46% in 1989 to approximately 13% in 2009 (Figure 3). Most of the decline over this twenty-year period is not attributed to growth in corn-ethanol production, since corn-ethanol represented a relatively small percentage of total corn usage prior to 2004. Corn used for ethanol accounted for approximately 10% of total usage in 2002, but accounts for approximately 24% in 2008 (Trostle, 2008). Over the longer term, tight supplies are attributed to other factors, such as

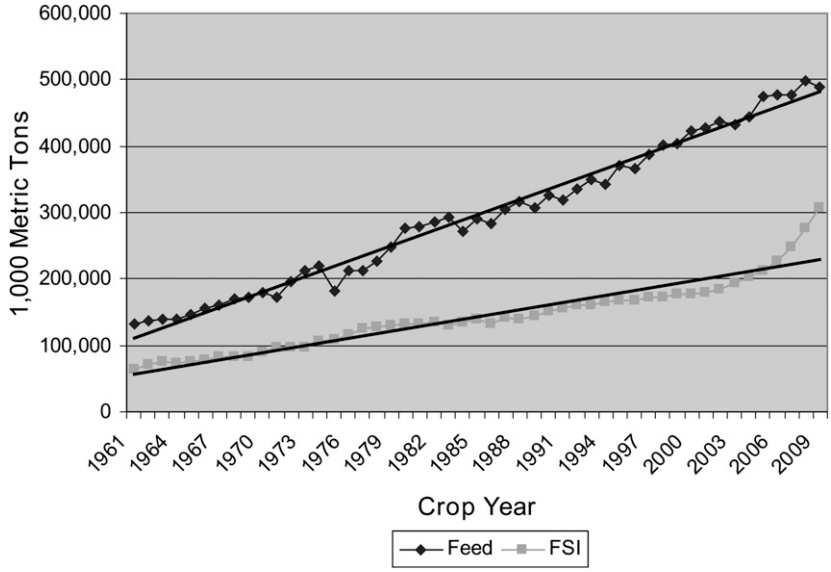

Figure 2. World Use of Corn—Feed and Food, Seed and Industrial (FSI) (Source: USDA Foreign Agricultural Service, Production, Supply, and Distribution Data, Sept. 2008)

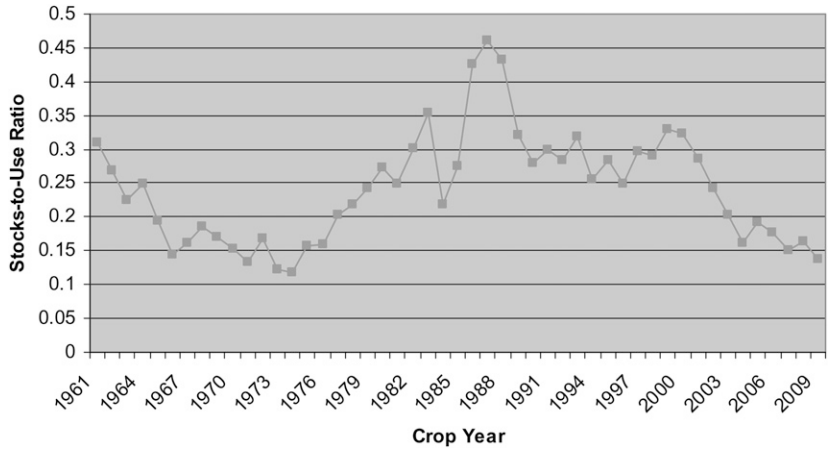

Figure 3. World Stock-to-Use Ratio for Corn (Source: USDA Foreign Agricultural Service, Production, Supply, and Distribution Data, Sept. 2008)

the previously discussed growth in corn used for feed, slowing growth in crop yields due to reductions in funding for agricultural research, land diverted from agricultural to nonagricultural uses, and availability and rising cost of irrigation (Trostle, 2008). However, in the last five years the stocks-to-use ratio for corn has decreased by 27.8% to a low of 13%, and much of this decline is associated with increased demand for corn-based ethanol. Therefore, the growth in demand for feed does contribute to demand growth in the long run, which supports the argument that increased demand for animal protein is a long term driver of corn prices. On the other hand, the short term growth in demand for corn is directly associated with increased demand for ethanol. If supplies are tight, as they have been in recent years, a short run surge in corn-ethanol leads to relatively large effects on prices.

The above-mentioned discussion is supported by empirical evidence from Iowa State University's Center for Agricultural and Rural Development (CARD). For instance, Tokgoz, et al. (2007) estimated the effects of ethanol on corn prices under various oil-price and biofuel policy scenarios. Their 2007 estimates, which assume $85 per barrel of oil, showed that increased demand for corn-based ethanol resulted in a corn price of $4.42 per bushel. This is a 40.3% increase relative to their baseline estimate of $3.15 per bushel, which assumed $75 per barrel of oil. It is important to note that the increase in corn is driven by an increase in demand for ethanol, but this is largely associated with an increase in the price of oil. The magnitude of this effect is amplified by tight supplies of corn on global markets.

Biodiesel and Vegetable Oil Prices

World stock-to-use ratios for soybean oil have also trended down from a high of approximately 17% in the mid-1990s to a low of approximately 6% in 2009 (Figure 4). Tight supplies in the last four years are a result of increased demand for soybean oil, which has grown faster than production. For instance, total usage has increased by 19% since 2005, whereas supply has increased by only 15% over the same period. Soybean oil is used as a cooking oil and a food ingredient, but also as the primary feedstock for biodiesel in the United States. Food usage of soybean oil accounts for approximately 89% of total usage, whereas industrial use (primarily for biodiesel production) accounts for approximately 11% of total use. Food use has risen significantly since the mid-1970s, whereas industrial use remained relatively flat until 2006 (Figure 5). After 2005, as biodiesel production increased, industrial use increased by 358.5% compared with 8.4% for use as food. However, even though industrial uses have increased sharply

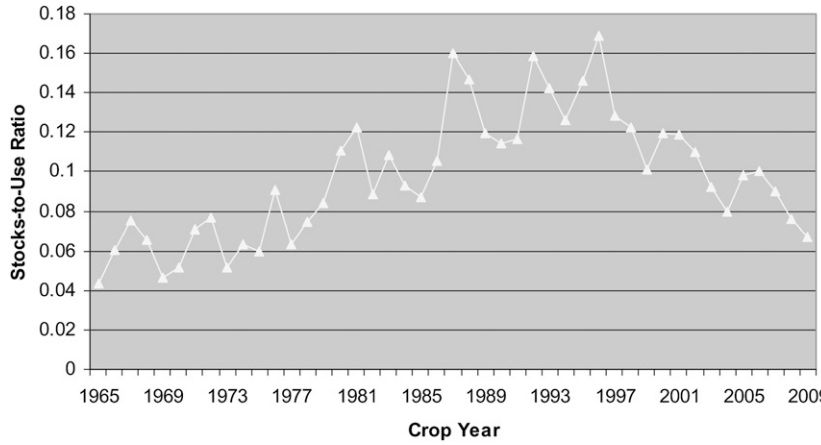

Figure 4. World Stock-to-Use Ratios for Soybean Oil (Source: USDA Foreign Agricultural Service, Production, Supply, and Distribution Data, Sept. 2008)

over the last four years, industrial use remains only a small percentage of the total demand for soybean oil (11%). In 2007, CARD estimates indicated that soybean oil price increased from 30.30 to 39.36 cents per pound under scenarios of $75 and $85 oil, respectively (Tokgoz et al., 2007). This is a 29.9% increase relative to their baseline estimate.

Rapeseed oil is the other primary feedstock for world production of biodiesel. The EU has utilized a range of public policies to promote use of rapeseed oil for biodiesel. The contribution of industrial use of rapeseed oil to total vegetable oil use has increased from 8% in 2000 to 27% by 2008 (Abbott, Hurt, and Tyner, 2008). World industrial use over the 2004–2008 time period has increased by 80%, whereas food usage has increased by 20% (Abbott, Hurt, and Tyner, 2008). Most of the growth in industrial use is attributed to the EU's expansion of biodiesel. This suggests that increases in rapeseed use for biodiesel production may play a larger role in higher vegetable oil prices relative to soybean oil. However, even though there has been higher growth in industrial usage for total vegetable oils in recent years, food usage for total vegetable oils in the long term has increased more. Hence, it is unclear

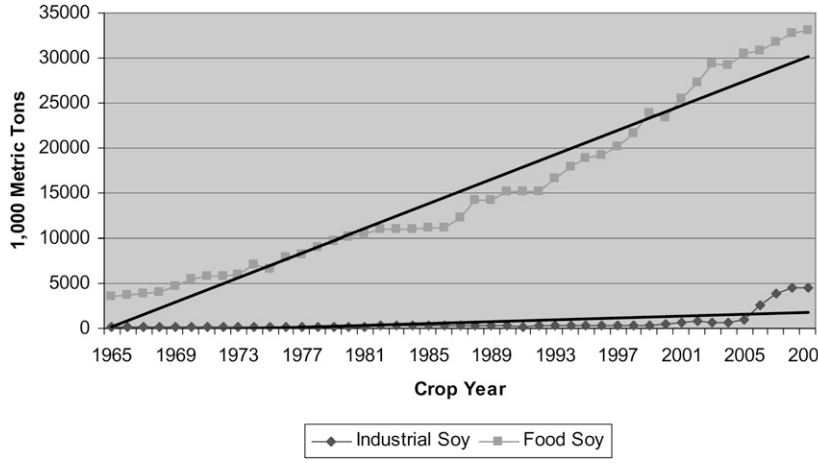

Figure 5. World Soybean Oil Usage (Source: USDA Foreign Agricultural Service, Production, Supply, and Distribution Data, Sept. 2008)

whether expansion of biodiesel production has significantly affected vegetable oil prices.

Links to Retail Food Prices

Percentage changes in the U.S. consumer price index (CPI) relative to previous years are reported in Table 1 for major food categories. The CPI for all foods has trended up since 2004, reaching a high of 5.2% in September 2008. Prices for food consumed at home have increased by 6.5% in 2008, which is 1.7 times greater than food consumed away from home. Categories associated with the greatest gains for 2008 are fats and oils, processed fruits and vegetables, and cereal and bakery products, all of which increased by greater than 10%. Categories increasing between 5% and 10% include most of the meat, poultry and fish products, with increases ranging from 5.7% for fish and seafood to 7.8% for pork products. Sugar and sweets, nonalcoholic beverages, and other foods also increased between 5% and 10% in 2008. Food categories increasing by less than 5% were all fruits and vegetables, except those that are processed, as well as dairy, which increased by 4%. However, dairy prices were significantly higher in 2007. Eggs were the only category that decreased in 2008 (by 6.2%), although they were at a historical high in 2007.

Retail food prices are determined by changing supply and demand conditions at various stages within vertical markets. In general, rising commodity prices such as those experienced in recent years put upward pressure on the costs of food production, which in turn put upward pressure on retail prices. Evidence presented in the previous section suggests that increased demand for corn-ethanol has affected corn prices in recent years. Corn is an important ingredient in many animal feeding

Table 1. Change in the Consumer Price Index (CPI) for Selected Food Categories

Item	Shares[a]	2004	2005	2006	2007	2008
Consumer price indexes	Percent	Percent change[b]				
All food	100	2.6	2.3	2.2	4.8	5.2
Food away from home	44.6	3.0	3.2	3.2	4.2	3.8
Food at home	55.4	2.4	1.7	1.4	5.6	6.5
Meats, poultry, and fish	12.2	2.3	1.4	1.0	4.0	6.5
Meats	7.9	1.6	1.2	0.9	3.3	6.4
Beef and veal	3.8	−0.9	2.2	0.5	5.0	6.7
Pork	2.4	4.7	−0.1	0.7	1.4	7.8
Other meats	1.7	2.9	0.8	2.0	1.8	3.9
Poultry	2.3	5.1	0.3	−0.7	6.3	5.7
Fish and seafood	2	2.3	3.8	3.5	4.7	7.5
Eggs	0.9	−19.9	1.4	14.1	32.6	−6.2
Dairy products	6.4	4.1	1.7	−1.2	13.4	4.0
Fats and oils	1.5	6.2	−1.3	0.9	5.6	17.2
Fruits and vegetables	8.4	7.9	0.6	1.9	5.9	5.0
Fresh fruits and vegetables	6.6	9.6	−0.5	1.8	6.4	2.7
Fresh fruits	3.4	7.3	1.3	4.3	5.8	3.7
Fresh vegetables	3.2	11.9	−2.3	−0.8	7.0	1.7
Processed fruits and vegetables	1.8	1.6	5.3	2.7	4.0	13.0
Sugar and sweets	2	0.2	4.0	2.7	3.6	6.3
Cereals and bakery products	7.4	1.7	1.0	3.1	5.4	10.8
Nonalcoholic beverages	6.7	0.9	3.5	2.1	3.5	5.1
Other foods	9.9	−0.7	2.8	0.1	2.6	6.9

[a] Source: USDA/ERS, U.S. Bureau of Labor.

[b] Source: U.S. Bureau of Labor Consumer Price Index Statistics, September 2008.

rations, and corn-based ingredients are used in many food products. Therefore, we expect that higher corn prices will have some effect on retail food prices. Unfortunately, the transmission of commodity prices to retail prices is complex. The following section discusses what we know about the transmission of higher corn prices to retail food prices.

The basic theoretical linkage between corn-base ethanol and retail food prices assumes that total demand for corn is composed of three components: the demand for feed, the demand for corn as a food ingredient, and the demand for corn as a feedstock for ethanol. Increased demand for corn-based ethanol leads to increased total demand for corn and the diversion of corn supplies from feed and food to ethanol production. This increases the price of corn, which increases the cost of production for food processors, and feed costs for industries that utilize corn in feeding rations, causing their respective supply curves to shift to the left, and thus increasing wholesale and retail prices for corn-based foods. However, the linkage between farm and retail prices is complex since many factors other than commodity prices affect the costs associated with food processing and distribution. These include the costs of labor, packaging, transportation, energy, and other items—all of which have increased in recent years. These factors are reflected in food marketing margins. The ERS/USDA 2006 estimates of the contribution of farm prices and marketing margins to retail food prices are presented in Table 2. In general, the marketing margin accounts for 81% of the retail value of food, whereas only 19% is associated with commodity prices on average. However, food products that require less processing, such as fresh vegetables, whole milk, and eggs, are associated with a relatively higher farm-value percentage. In addition to marketing costs, industry structure and relative supply and demand elasticities also have significant effects on the degree that food suppliers can pass higher costs onto consumers.

The issue of tracing corn prices through to retail prices is further complicated by the varying degrees to which food categories depend on corn and corn-based ingredients. For instance, the degree to which higher corn prices affect retail prices for margarine made from corn oil is substantially different from the affect of corn prices on retail prices for butter made from milkfat. Dairy products are affected by higher corn prices through higher feed costs. Moreover, linkages between corn price and all livestock-based food products are further complicated by differences in feeding rations, feed conversion ratios, and the lengths of their respective production cycles. Beef, pork and poultry all utilize corn as a primary feed ingredient, but the feed conversions are 7-to-1, 6.5-to-1, and 2.6-to-1 pounds of corn to one pound of grain for the three industries, respectively. These examples illustrate the innate complexity of tracing commodity prices through to retail prices, thus making general conclusions about the effects of corn-based ethanol on retail food prices tenuous.

Table 2. What a Food Dollar Paid for in 2006

Component	Percent or Cents	Billion Dollars
Farm value	19.0	163.2
Labor	38.5	341.0
Packaging	8.0	70.5
Transportation	4.0	35.2
Energy	3.5	33.5
Profits	4.5	39.7
Advertising	4.0	34.9
Depreciation	3.5	31.5
Rent	4.0	37.6
Interest	2.5	23.9
Repairs	1.5	13.5
Business taxes	3.5	31.0
Other costs	3.5	25.2
Total	100	880.7
Marketing bill		717.5

Source: Economic Research Service, U.S. Department of Agriculture

Despite these complexities, there have been studies that attempt to estimate the effects of corn prices on selected retail foods. Tokgoz et al. (2007) estimated that a 30% increase in the price of corn, and associated increases in the prices of wheat and soybeans, would increase egg prices by 8.1%, poultry prices by 5.1%, pork prices by 4.5%, beef prices by 4.1%, and milk prices by

2.7%. At-home food prices were estimated to increase by 1.3% and food consumed away from home increased by 0.9%.

Conclusions

The general conclusion of this paper is that growth in biofuels production since 2004 has contributed to higher corn prices. The factors driving higher prices are a combination of tight global supplies, which have been developing since the late 1980s as a result of increased usage for feed in the long term and increased demand of corn ethanol in the short term. Another important conclusion is that the increased demand for corn ethanol is largely associated with high oil prices. The paper also reports evidence from other studies which indicate that increased corn prices contributed to food price inflation for food items that depend on corn as a primary feed. These include eggs, poultry, pork, beef and milk. These findings imply that price inflation for these food items is related to increased production of corn ethanol, primarily because of high oil prices. Moreover, higher oil prices also result in higher fuel and energy costs, which increase the marketing costs associated with all food categories.

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