Economic Research Service
U.S. DEPARTMENT OF AGRICULTURE

Economic Research Service

Economic Information Bulletin Number 224

September 2021

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Economic Research Service
www.ers.usda.gov

Recommended citation format for this publication:

Page, Elina T., Gianna Short, Stacy Sneeringer, and Maria Bowman. September 2021. *The Market for Chicken Raised Without Antibiotics, 2012–17,* EIB-224, U.S. Department of Agriculture, Economic Research Service.

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Abstract

This report estimates consumer retail expenditure distributions and prices of chicken products labeled raised without antibiotics (RWA) between 2012 and 2017 and characterizes the demographics of households that purchased RWA-labeled chicken products. The analysis considered three different chicken product market segments: classic, processed, and sausage. Using household scanner data merged with a dataset of poultry product label claims, the results reveal household expenditures for RWA-labeled products grew substantially within each of the three market segments. The average price per pound for RWA-labeled chicken products was also considerably higher than conventional products within each market segment. Additionally, households that purchased RWA-labeled chicken products were on average larger, had higher incomes, were more likely to have a primary food shopper with a college degree, and were more likely to report being very concerned about antibiotic use in meat production.

Keywords: Antibiotics, organic, chicken, poultry, consumer demand, prices, raised without antibiotics, food labels, credence attributes, scanner data

Acknowledgments

The authors would like to thank Michael Sheats, USDA, Agricultural Marketing Service (AMS) for AMS estimates and Megan Sweitzer for IRI data expertise. They also thank the following individuals for technical peer reviews: Seanicaa Herron and Cindy Nickerson, USDA, Office of the Chief Economist; Michael Ollinger, USDA, Economic Research Service; Andrew Pugliese, USDA, Food Safety and Inspection Service; Lisa House, University of Florida; and Ted Schroeder, Kansas State University. Thanks also to USDA, Economic Research Service editor Andrew Nash and designers Andrew Levin and Tiffany Lanigan for their help in producing this report.

The analysis, findings, and conclusions expressed in this report should not be attributed to IRI.

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A report summary from the Economic Research Service September 2021

The Market for Chicken Raised Without Antibiotics, 2012–17

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What Is the Issue?

Producers in the chicken (broiler) industry have historically used antibiotics to promote animal growth, prevent disease, and treat sick animals. While the use of medically important antibiotics for growth promotion was eliminated in the United States in January 2017, a number of classes of antibiotics important for treating human disease are used for the treatment, control, and prevention of animal disease. The continued use of antibiotics in broiler production raises consumer concerns about antibiotic resistance, which can make human and animal infections increasingly difficult and costly to treat. In recent years, largely due to media coverage, consumers have become increasingly wary of antibiotic use in meat and poultry production, and a growing market for chicken products raised without any antibiotics has emerged. This report estimates the extent and growth of that market. Specifically, this report estimates consumer retail expenditure distributions and prices of chicken products labeled raised without antibiotics (RWA) between 2012 and 2017 and characterizes the demographics of households that purchased RWA-labeled chicken products.

What Did the Study Find?

The analysis grouped chicken products into three distinct market segments: classic, processed, and sausage. The classic chicken segment includes all raw, fresh or frozen, minimally processed chicken products sold in uniform weights (e.g., a package of frozen bone-in chicken breasts). The processed chicken segment includes all uniform-weight, fresh or frozen chicken products that are cooked, marinated, breaded, or fried (e.g., breaded chicken breast tenders). Finally, the chicken sausage segment includes all uniform-weight chicken sausage products. Between 2012 and 2017, household expenditure shares for RWA-labeled products grew substantially within each of the three market segments. In 2012, RWA-labeled products only represented 4 percent of the classic market, 1 percent of the processed market, and 7 percent of the sausage market. By 2017, RWA-labeled products represented 11, 9, and 18 percent of the markets, respectively.

Between 2012 and 2017, RWA-labeled products also commanded higher prices per pound than conventional chicken products. For classic, processed, and sausage chicken products, RWA-labeled products had prices that were on average 87, 55, and 48 percent greater than conventional products, respectively.

U.S. Department of Agriculture (USDA)-certified organic products are also raised without antibiotics, but they are subject to additional production requirements, including organic feed and year-round access to the outdoors. These products exhibited little market growth over the time period examined by the report. These findings suggest there is significant consumer interest and market opportunities for production practices between conventional and organic.

Lastly, on average, households that purchased RWA-labeled chicken products were larger, had a greater likelihood of having children present, had higher incomes, and were more likely to have a primary food shopper with a college degree. Households that bought RWA-labeled chicken products were also more likely to report that they were very concerned about antibiotic use in meat production than those that did not purchase RWA-labeled chicken products.

How Was the Study Conducted?

This report features an analysis of proprietary household scanner data from IRI, a market research company, for the years 2012 to 2017, focusing on uniform-weight chicken product purchases. The household scanner data, known as the Consumer Network, are nationally representative and include detailed information on household food purchases from retail food stores, as well as household demographic information. A subset of the households also completed a MedProfiler survey on health concerns, medical conditions, diet, and lifestyle. Data on chicken product label claims were compiled from three sources: Label Insight, the USDA, Food Safety and Inspection Service (FSIS) Label Submission and Approval System (LSAS), and independent data collection efforts. Together, the IRI household scanner data and the constructed dataset of chicken product labels allow for an analysis of expenditure shares, national average prices, and demographics for RWA-labeled chicken products.

Expenditure shares for conventional, RWA, and organic chicken were calculated as the percent of total dollar expenditures within each of the three market segments (classic, processed, and chicken sausage). For example, the expenditure share of RWA-labeled chicken in the classic market is the percentage of all household expenditures on classic chicken that is labeled RWA. Average prices per pound (in 2017 dollars) for conventional, RWA, and organic products were also calculated for each market segment.

Lastly, household demographics were compared for three sets of households: (1) households that purchased an organic chicken product, (2) households that purchased an RWA-labeled chicken product (but not an organic product), and (3) households that only purchased conventional chicken products in 2017. Differences in demographics and self-reported concerns about antibiotic use in meat production were tested for significance.

The Market for Chicken Raised Without Antibiotics, 2012–17

Introduction

Antibiotics—pharmaceutical drugs that destroy or slow the growth of bacteria—have historically been used in food animal production to promote animal growth, prevent and control disease, and treat illness. However, any use of antibiotics (in humans or animals) can encourage antibiotic resistance, which occurs when some bacteria in a population survive exposure to an antibiotic and continue to grow, passing on their resistant genes (CDC, 2013; CDC, 2019). Antibiotic resistance, in turn, can make the treatment of human and animal infections increasingly difficult and costly and is considered one of the greatest current threats to global health (WHO, 2019).

In recent years, consumers have become increasingly concerned about antibiotic use in meat and poultry production (Brewer and Rojas, 2008). Both policymakers and industry have responded to these concerns. The U.S. Food and Drug Administration (FDA) implemented a set of new policies that effectively made the use of medically important antibiotics for animal growth promotion illegal in the United States as of January 2017.[1] Such antibiotics may still be used to treat, control, and prevent animal disease but with increased veterinary oversight. On the industry side, several large poultry firms and major fast food chains have transitioned toward sourcing and raising broilers (young chickens bred for meat) without the use of any antibiotics.[2]

The rise of chicken products labeled raised without antibiotics (RWA) in the United States has been led by a couple of key poultry industry companies. Perdue Farms, the fourth-largest producer of broiler chickens in the United States, began labeling chicken as RWA in 2007, and in the fall of 2016, announced it had eliminated all antibiotic use except for the treatment of disease (Charles, 2016). Broilers that are ultimately treated for illness, about 3 percent of all Perdue broilers, are sold under different product lines (i.e., not Perdue). Tyson Foods, the largest broiler producer, similarly announced in 2017 that it would eliminate all antibiotic use except for disease treatment (Shaffer, 2017). As a result of these major producers' shifts in production, as well as those from a number of smaller firms, the share of RWA broilers has grown considerably over the last decade.

Despite the growing trend to eliminate antibiotic use in poultry production and to label poultry products as RWA, little is known about the consumer market for RWA claims in the broiler industry. Existing research on RWA and other process-based, single-attribute claims has examined consumer confusion surrounding these claims, particularly when there is little to no regulatory oversight or definitive standard (Bowman et al., 2016; Messer et al., 2017). Multi-attribute claims, such as U.S. Department of Agriculture (USDA)-certified organic labels, can also be a source of consumer confusion (Kuchler et al., 2017a). Organic labels, which elicit significant price premiums (Carlson and Jaenicke, 2016), represent a wide range of production standards and prohibit the use of genetic engineering, antibiotics, hormones, and most synthetic pesticides and fertilizers. Consumers, however, may not be aware the organic label also signals RWA.

[1] The FDA characterizes two broad types of antibiotics in terms of their relation to human health. "Medically important" antibiotics are those pertinent to human disease treatment. As of January 2017, such drugs cannot be distributed to animals via feed or water for purposes of growth promotion or feed efficiency. Medically important antibiotics still can be used for animal disease treatment, control, and prevention, but only under the guidance of a veterinarian. The other type of antibiotic is "not currently medically important" or "non-medically important." This type of antibiotic is largely comprised of ionophores.

[2] This means that neither medically important nor non-medically important antibiotics are used.

Understanding the size of the market, price differentials, and consumer demographics for RWA-labeled products can inform companies considering RWA in their production lines. This type of research can also inform public health groups interested in promoting RWA in food production. If one method of reducing inappropriate use of antibiotics in food production is to encourage consumer demand for RWA products, then it becomes important to understand the limits of this market. Specifically, the extent of the demand and the prices that consumers pay are important markers in gauging how much the market (outside of regulations) can achieve the public health goal of reducing the need for antibiotics in food animal production.

The objective of this report is to begin to understand consumer demand for meat products raised without antibiotics. Specifically, this report estimates the share of retail expenditures and average prices of RWA-labeled chicken products from 2012 through 2017 using household-level scanner data. The period chosen for analysis, 2012 to 2017, overlaps with a critically important regulatory period for antibiotic use in food animal production with increased restrictions on the use of antibiotics (Sneeringer et al., 2019). The analysis also compares the demographics of consumers who purchase RWA-labeled products to consumers who purchase organic or only conventional products.

Background

The Broiler Industry

The broiler chicken industry is an industrialized sector of livestock agriculture, characterized by market concentration among a limited number of vertically integrated firms. Almost all U.S. broiler production is carried out through contracts between growers and integrators with compensation based on relative performance. Integrators are large poultry firms that own the birds, hatcheries, feed mills, processing plants, and transportation networks and contract with individual farmers to raise the birds to market weight. Integrators dictate feed formulations, the administration of medications to flocks, and certain bird housing specifications and production practices, while contract growers provide labor, management, and housing services (MacDonald, 2014).

Most contract growers are relatively small and specialized farms. Eighty-five percent of 15,516 contract growers reported sales (annual gross cash farm income) of less than $350,000 in 2011, and nearly half of all contract growers exclusively raised broilers (MacDonald, 2014). In contrast, the 20 largest integrators accounted for 95 percent of all broilers produced in the United States in 2017, and the largest 5 integrators accounted for 59 percent (table 1). Largely because of the industry structure, U.S. broiler production has grown considerably since 1960 (MacDonald, 2014). Innovations in breeding, mass production, contract farming, vertical integration, and marketing have made chicken products more abundant and affordable. In 2010, the per capita supply of chicken in the United States exceeded that of beef for the first time (Bentley, 2012), and in 2017, the per capita annual availability of boneless chicken was 63.4 pounds (USDA-ERS).

Table 1
Top five U.S. broiler integrators, 2017

Rank	Firm	Slaughter plants	Average weekly slaughter (million head)	Average broiler size (pounds)
1	Tyson Foods	32	35.16	5.80
2	Pilgrim's Pride Corp.	26	30.28	5.72
3	Sanderson Farms Inc.	11	10.76	8.20
4	Perdue Farms	11	13.13	5.99
5	Koch Foods Inc.	8	12.00	5.30
	Largest 5 integrators	**88**	**101.33**	**6.00**
	All U.S. production		**171.46**	**6.11**

Source: WATT Poultry USA, March, 2018. Companies ranked by total liveweight (lb). U.S. production figures sourced from USDA, National Agricultural Statistics Service, Poultry Slaughter.

While similar models of production have been used in other agricultural industries (e.g., hog production), vertical integration is most extensive in the broiler industry. Because of concentration in the broiler industry, decisions by single integrators can impact large segments of the market, and because the broiler industry is largely vertically integrated, companies can easily implement uniform production practices by stipulating how birds are raised through contract provisions. Both of these factors are critical for explaining the growing share of broilers raised without antibiotics.

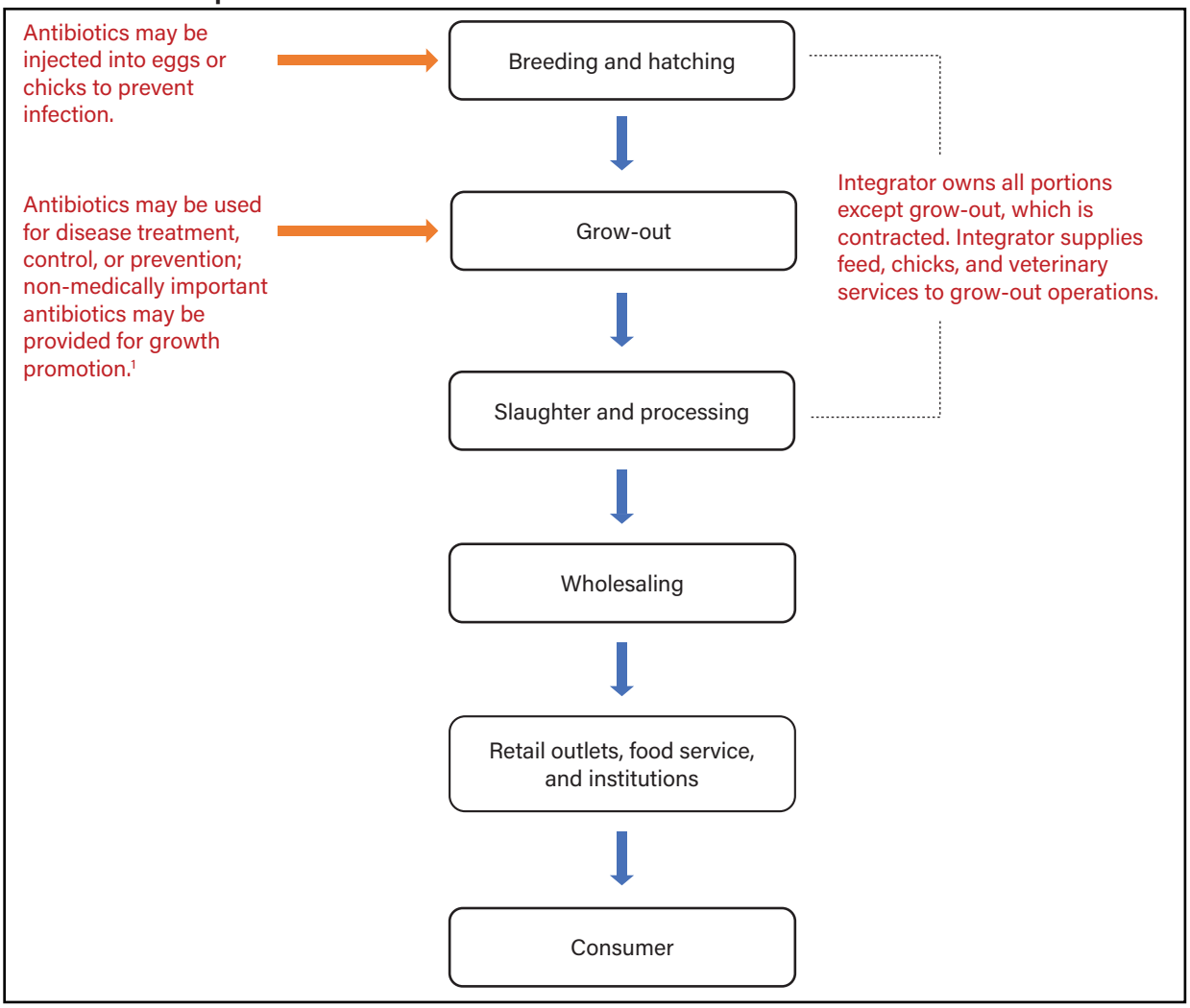
Antibiotics and Alternatives Used in Broiler Production

Antibiotics are administered to broilers to prevent, control, and treat disease and to promote growth (National Research Council, 1999), but consumer concerns about antibiotic resistance has led to policies to optimize antibiotic use in food animal agriculture. In 2017, the use of antibiotics important to human medicine for production purposes (growth promotion or improved feed efficiency) became effectively illegal in the United States (FDA, 2012, 2013). However, non-medically important antibiotics (specifically ionophores) may still be used for growth promotion.[3]

Among poultry growers, *Salmonella, Escherichia coli (E. coli),* and *Clostridium* are major bacterial concerns associated with illness in flocks (Barrow et al., 2012; Fancher et al., 2020). Antibiotics may be used to treat sick birds, and flocks may also be given a course of antibiotics in feed or water to prevent disease when there is a high probability of infection or to control an identified infection in nearby houses or farms (Sneeringer et al., 2015). When a higher than average number of sick birds are removed from a barn, this provides a signal that the rest of the birds may need a course of antibiotics for disease treatment. Antibiotics are also injected into eggs or chicks to improve early viability; in eggs, the antibiotics are used to inoculate the hole created from injecting vaccines (figure 1). If an animal does receive antibiotics at any point, an FDA-approved withdrawal period is observed before the animal enters the food supply to ensure there are no antibiotic residues in the final food product.

[3]Ionophores are a class of antibiotics that are used only in animals, and ionophore use has not yet been shown to contribute to resistance to other classes of antibiotics (Callaway et al., 2003).

Figure 1
Phases of broiler production and antibiotic use



[1]Non-medically important antibiotics are those that are not pertinent at present for human medicine.

Source: USDA, Economic Research Service.

While antibiotic use has clear benefits in broiler production, it can also lead to resistance (see box "Antibiotics and Antibiotic Resistance"). There are, however, a range of interventions and practices that can be used to reduce the incidence of on-farm diseases without the use of antibiotics. These include hatchery sanitation investments, rodent control programs, breeding flock vaccination, flock stress reduction, flock testing, prebiotic or probiotic feed supplements, vehicle cleaning and disinfection, and litter treatment to reduce ammonia emissions (Fancher et al., 2020).[4] Additionally, nearly all commercial producers use an all-in, all-out system, with all chicks placed in the poultry house at the same time and all grown broilers removed and taken to slaughter at the same time. All-in, all-out production can make it easier to control the spread of disease since it reduces the chances of infections spreading from flock to flock.

Integrators that endeavor to market broilers as having never received any antibiotics may institute heightened attention to disease prevention and control. When flocks have elevated rates of sick birds, growers may decide to treat the entire flock with antibiotics. However, these birds are then sold under a different product line. Producing broilers without antibiotics requires careful management and some changes in practices, but most broilers that are raised without antibiotics are still raised in poultry houses using production practices similar to conventional production (Bowman et al., 2016).

[4]Litter is a mixture of poultry excreta, spilled feed, feathers, and material used as bedding in poultry operations.

Antibiotics and Antibiotic Resistance

Antimicrobials are drugs or substances that can kill or impede the growth of microbes such as viruses, fungi, parasites, and bacteria. Antibiotics are a subgroup of antimicrobials that specifically kill or impede the growth of bacteria. Therefore, an antibiotic is also an antimicrobial, but not all antimicrobials are antibiotics.*

Antibiotics are used to prevent and treat diseases in human medicine and prevent, control, and treat diseases in veterinary medicine. Antibiotics have also been used to promote growth in food animals in the United States since the 1950s (McEwen and Fedorka-Cray, 2002; Marshall and Levy, 2011). While non-medically important antibiotics (those not relevant for human disease treatment) can still be used for growth promotion, the use of medically important antibiotics for growth promotion practices ended in 2017 with a set of new U.S. Food and Drug Administration (FDA) policies.

Antibiotic resistance occurs when some bacteria in a population survive exposure to an antibiotic and continue to proliferate, passing on their resistant genes. The use of antibiotics in human medicine and agriculture accelerates the development of resistance by applying this selective pressure to bacterial populations (Davies and Davies, 2010; CDC, 2013; CDC, 2019).

Scientists agree that the use of antibiotics in food animal production can lead to antibiotic resistance but do not understand how much of the burden of resistance for human health can be directly or indirectly attributed to the use of antibiotics in livestock (Chang et al., 2015). Scientific studies have explored the mechanisms by which the use of antibiotics on farms can yield antibiotic resistance that is clinically relevant for humans. Antibiotic-resistant bacteria persist in animal manure, which is often spread on fields and can run off into streams, enter groundwater, and possibly even contaminate agricultural produce (Chee-Sanford et al., 2009; Marti et al., 2013; Wellington et al., 2013). Resistant bacteria can also travel through the air, escape into the environment when animals are shipped, and colonize livestock or processing plant workers who then interact with family or the community (Price et al., 2007; Rule et al., 2008; Marshall and Levy, 2011; Rinsky et al., 2013; Smith et al., 2013; Castillo Neyra et al., 2014). Finally, resistant bacteria may be present on retail meat and poultry products (Chen et al., 2013; Ge et al., 2013; Sjölund-Karlsson et al., 2013; Zhao et al., 2015), and resistant foodborne bacteria have the potential to make foodborne illness more costly or difficult to treat.

*Despite these differences, the terms antimicrobials and antibiotics are often used interchangeably. As FDA notes: "The term 'antimicrobials' refers broadly to drugs with activity against a variety of microorganisms including bacteria, viruses, fungi, and parasites. Antimicrobial drugs that have specific activity against bacteria are referred to as antibacterial or antibiotic drugs. However, the broader term 'antimicrobial,' commonly used in reference to drugs with activity against bacteria, is used … interchangeably with the terms antibacterial or antibiotic" (FDA, 2012, p. 4).

Availability of Broilers Raised Without Antibiotics

In the mid-2000s, companies began to offer poultry products that were labeled RWA (Bowman et al., 2016). Perdue Farms, one of the Nation's largest broiler producers, was one of the first adopters of the claim. It began marketing its RWA Harvestland brand in 2007, and by the fall of 2016, Perdue announced it had eliminated all antibiotic use except for the treatment of disease (Charles, 2016). Tyson Foods, the largest broiler producer, announced in 2017 that it had also eliminated all antibiotics except for disease treatment (Shaffer, 2017).[5]

These shifts in production practices have largely been driven by growing consumer interest in the ways food is produced, such as organic and RWA. In particular, consumer awareness of antibiotic use in livestock production has increased considerably over the past couple decades largely because of media coverage and advocacy by organizations such as the Pew Charitable Trusts, Union of Concerned Scientists, and the Natural Resources Defense Council, which have publicized the risks of antibiotic use in animal agriculture (see Bowman et al., 2016; *Consumer Reports*, 2015; Mellon et al., 2004; *Pew Charitable Trusts*, 2008). Though raising animals without antibiotics is certainly more costly, producers can benefit from doing so when consumers are willing to pay price premiums for these process-based attributes (Bowman et al., 2016).

Over the last decade, the estimated production share of RWA chicken has grown considerably (table 2). In 2012, only 2.7 percent of production was estimated to be RWA.[6] In 2017, the estimated share was 44 percent. Notably, the share of RWA production increased by 26 percentage points between 2016 and 2017. For comparison, the share of USDA-certified organic broilers constituted less than 1 percent of production throughout this timeframe. While USDA-certified organic chickens are raised without antibiotics, they are also fed only organic feed and are subject to additional animal welfare and other requirements.[7]

[5]Broilers that are treated for disease are sold under different brand names.

[6]This does not include USDA-certified organic broilers.

[7]Visit the USDA, AMS website for more information on the USDA organic standard.

Table 2
Estimated production of young chicken by production method

	Conventional		Raised Without Antibiotics		Organic		Total
	Head (millions)	Share (percent)	Head (millions)	Share (percent)	Head (millions)	Share (percent)	Head (millions)
2012	8,185	97.1	224	2.7	20	0.2	8,429
2013	8,259	97.1	226	2.7	19	0.2	8,504
2014	7,713	90.5	796	9.3	16	0.2	8,525
2015	7,792	89.7	844	9.7	53	0.6	8,688
2016	7,140	81.4	1,574	18.0	54	0.6	8,768
2017	4,941	55.4	3,923	44.0	51	0.6	8,915

Source: USDA, Agricultural Marketing Service (AMS) calculations using data from AMS, USDA, National Agricultural Statistics Service, and USDA, Food Safety and Inspection Service.

Labeling Chicken Products Raised Without Antibiotics

The USDA, Food Safety and Inspection Service (FSIS) oversees and regulates all label claims for meat and poultry products, including voluntary process-based claims (e.g., organic, pasture-raised, RWA, etc.). While some claims, such as organic, are third-party certified, many animal-raising label claims are not audited, verified, or certified by a third party. Instead, the firm must provide supporting documentation to FSIS that the claim is truthful and not misleading (i.e., documentation demonstrating that the animals were raised without antibiotics), and these labels must be approved by FSIS before commercial use. Specifically for the RWA claim, the necessary documentation includes: (1) a detailed written description explaining controls for ensuring animals are not given antibiotics from birth to harvest, (2) a signed and dated document describing how animals are raised, (3) a written description of product tracing, and (4) a written description for the identification, control, and segregation of non-conforming animals (e.g., broilers that are treated with antibiotics because of illness) (USDA-FSIS, 2019). If approved, FSIS allows all of the following RWA labels on products: No Antibiotics Administered, Raised Without Antibiotics, No Added Antibiotics, No Antibiotics Ever, and other variations.

Market Growth for Chicken Products Labeled Raised Without Antibiotics

Data and Methodology

Despite increasing interest in labeling poultry products as RWA, little research examines the consumer market for RWA claims. Therefore, to estimate the retail market share and growth of chicken products labeled RWA, we analyzed proprietary household purchasing data from IRI, a market research company, for the years 2012 to 2017 (see box "IRI Household-Based and Store-Based Scanner Data"). The household scanner data, known as the Consumer Network, are nationally representative and include detailed information on household food purchases from retail stores (e.g., supercenters, grocery stores, and drug stores). For uniform-weight chicken products (i.e., chicken products not sold on a per-pound basis), data include a detailed product description, date of purchase, package size, and price. Though the product descriptions often include brand (e.g., Tyson, Pilgrim's Pride), style (e.g., original, premium), and packaging information (e.g., box, plastic bag), details on front-of-package health and production claims, including RWA claims, are often incomplete or lacking. For random-weight chicken products (i.e., products sold by the pound in varying weights and often store-packed), product information is even sparser. Only a subset of the households participating in the Consumer Network report total expenditures (but not quantities) on random-weight purchases across broad product categories (e.g., chicken, beef, etc.) with very limited type information (e.g., breast, thigh, etc.). For products such as fresh meat and poultry, which are often (but not always) sold in random-weight quantities, this presents a possible limitation, as there is no way to identify different product attributes, including any RWA claims.

To determine the extent of this limitation, we calculated nationally representative shares of total consumer expenditures for random-weight and uniform-weight chicken products for 2012-17 (figure 2). During this time, uniform-weight chicken products accounted for 34 to 39 percent of total expenditures on chicken products. The subsequent analysis of market shares focused only on these uniform-weight products.

IRI Household-Based and Store-Based Scanner Data

Since 2008, USDA, Economic Research Service (ERS) has purchased proprietary household and retail scanner data from IRI, a market research firm, to support critical food policy analysis and research. The two primary components of the data are the household food purchases (Consumer Network) and retail food sales (InfoScan). More information on the statistical properties of both data sources are detailed in ERS reports Muth et al. (2016), Sweitzer et al. (2017), and Levin et al. (2018).

Consumer Network

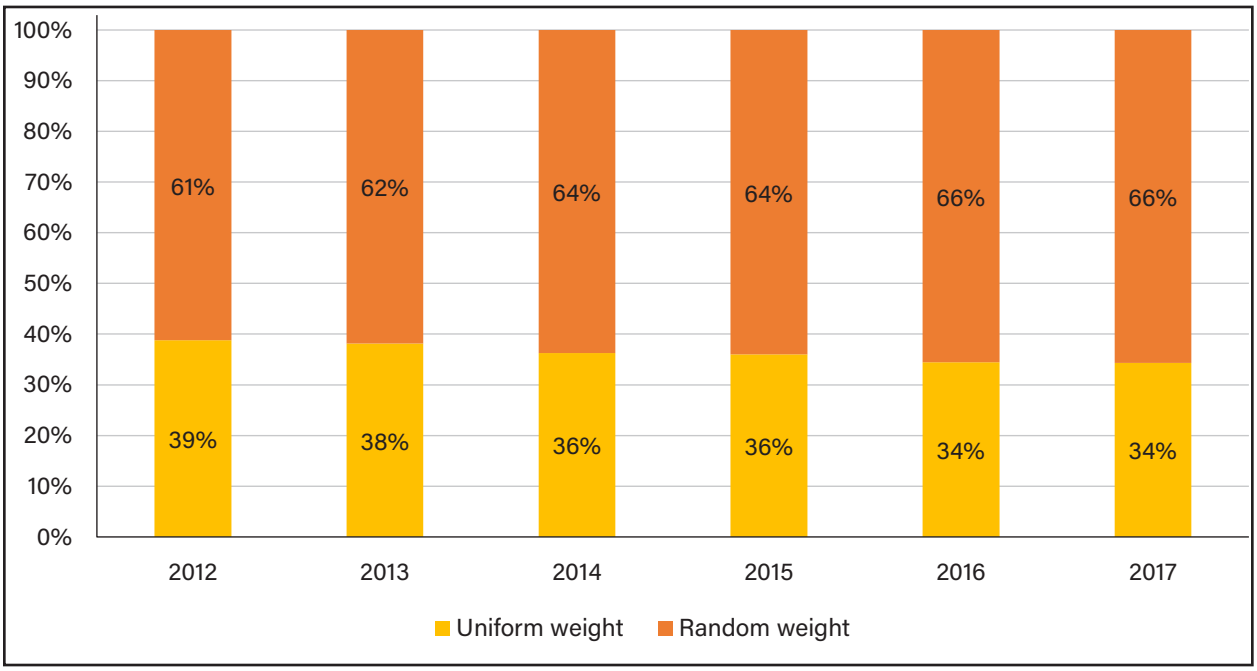
The IRI Consumer Network is a nationwide panel of over 120,000 households that provides a detailed account of their retail food purchases. The panel is selected to be geographically and demographically representative of the contiguous United States, and the data include survey weights to produce national estimates. Households participating in the panel download a mobile application or are provided with a handheld scanner to scan the Universal Product Code (UPC) on all their purchases and upload all information on a regular basis via the internet. Households also provide demographic information, including county of residence, household size, income, and race.

A subset of households also complete an annual opt-in MedProfiler survey on health concerns, medical conditions, diet, and lifestyle. Approximately one-third of the national panel has at least one household member respond to the MedProfiler survey.

InfoScan

InfoScan provides weekly transaction data for retail food outlets, including grocery stores, superstores, club stores, and convenience stores. The data include retail sales (revenues and quantities) for products with UPCs and random-weight (or perishable) products. Some of these data are available at the store level, while others are provided at the retailer marketing area (RMA) level in cases where the retailers did not approve the release of data at the store level. The geographic areas for the RMAs are defined separately by each retailer. The estimated coverage of food and alcohol sales is approximately 55 percent (Muth et al., 2016).

Figure 2
Expenditure shares of uniform-weight and random-weight chicken products, 2012–17



Note: Random-weight chicken products are sold on a per-pound basis in varying weights and often are store-packed, whereas uniform-weight chicken products are sold and priced at the item level in uniform weights.

Source: USDA, Economic Research Service estimates using 2012-17 IRI Consumer Network data and projection weights.

Uniform-weight chicken products, however, still do not have complete label claim information within the IRI data. Therefore, information from external sources must be merged with IRI data to estimate retail market share and growth of chicken products labeled RWA. Data on chicken product label claims were compiled from three sources: Label Insight, the USDA, FSIS Label Submission and Approval System (LSAS), and independent data collection efforts (see box "Label Claim Data"). Once chicken products and their label claims were identified and collated into a single dataset, the products were matched to purchases in the IRI Consumer Network. This was done by matching either the Universal Product Codes (UPCs) between the two datasets (when available) or by matching brand names known to be labeled RWA. Together, the IRI household scanner data and the constructed dataset of chicken product labels allow for an analysis of market shares and national average prices for RWA products.

Label Claim Data

The following three sources of data were used to construct a novel dataset of chicken product label claims. This dataset was then merged with the IRI household scanner data.

Label Insight

Label Insight is a proprietary database providing granular data on over 400,000 product labels. Available data include Universal Product Codes (UPCs), brands, nutrients per serving, ingredients, claims, and product images. Approximately 60 percent of raised without antibiotics (RWA)-labeled products were identified as RWA using Label Insight data.

USDA, Food Safety and Inspection Service Label Submission and Approval System

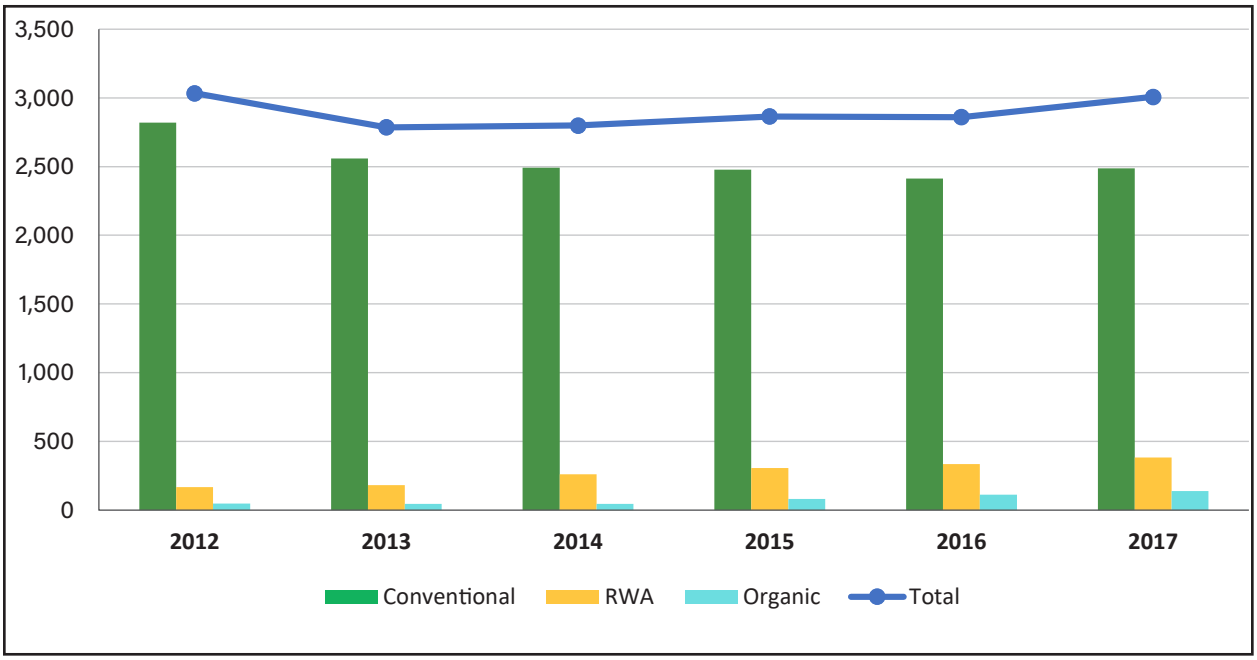
All special statements and claims on poultry products must be approved by the USDA, Food Safety and Inspection Service (FSIS). Some claims that require label approval include all natural, no additives, humanely raised, organic, RWA, etc. (USDA-FSIS, 2015; USDA-FSIS, 2017, USDA-FSIS, 2019). To submit a label for approval, industry representatives may submit an application, a copy of the proposed label, and documentation that supports any special statements or claims. Administrative data from this approval system include the brand, manufacturer, and special claims. Label claims sourced from the Label Submission and Approval System (LSAS) largely overlapped with Label Insight claims and were mainly used for verification.

Independent Data Collection

When claim information was not available from Label Insight or the USDA, FSIS LSAS, researchers conducted internet searches to glean publicly available information on label claims. Searches included both a review of manufacturer websites and a review of product image search results.

Household participation and commitment to the Consumer Network panel varies from year to year. Therefore, IRI determines whether to include a household in the annual static panel based on specific criteria. The static panel only includes households that reported purchases at least once every four weeks for 80 percent of the year (11 of 13 four-week periods) and reported minimum average expenditures of $25 per week for one-member households, $35 per week for two-member households, and $45 per week for three-or-more member households (Muth et al., 2016). The present analysis only considers households in the static panel or approximately 60,000 households annually between 2012 and 2017. In total, these households purchased approximately 3,000 different unique, uniform-weight chicken products from year to year, with the number of products identified as RWA (but not organic) increasing from 166 in 2012 to 383 in 2017 (figure 3). Meanwhile, the number of unique, uniform-weight chicken products identified as organic remained low throughout 2012–17, reaching 138 products in 2017.

Figure 3
Number of unique, uniform-weight chicken products purchased by the IRI Consumer Network, 2012–17

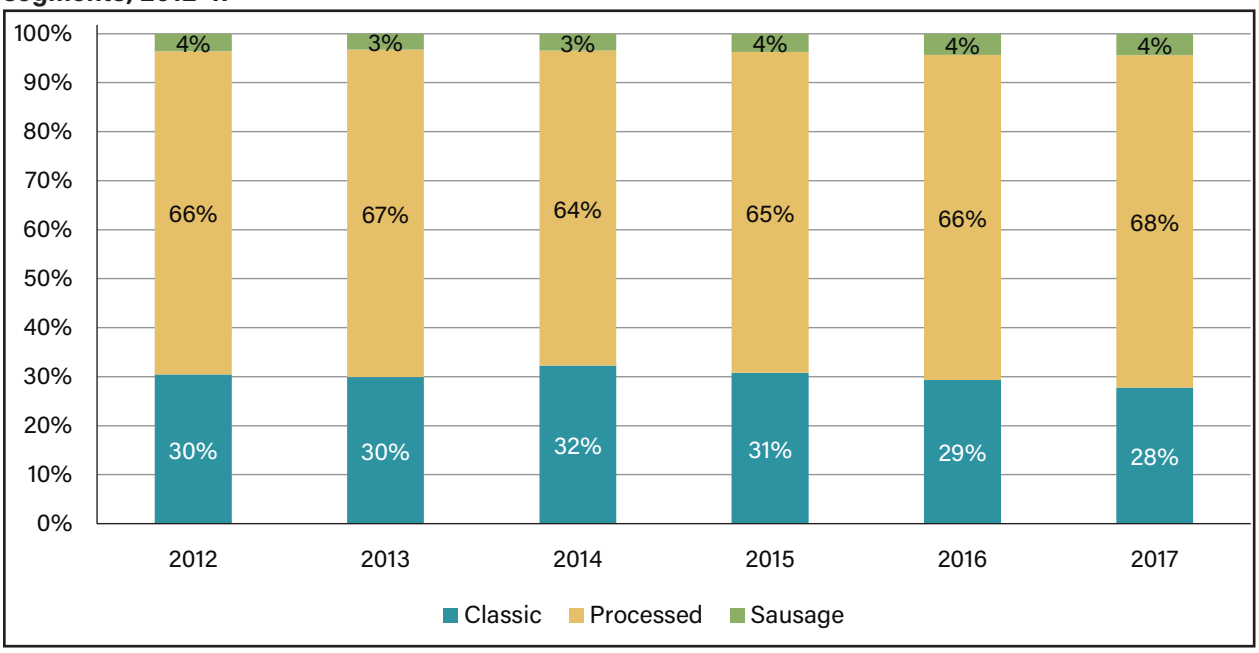


Note: Uniform-weight chicken products are sold and priced at the item level in uniform weights. Values represent the number of unique, uniform-weight chicken products purchased by static households participating in the IRI Consumer Network. RWA = raised without antibiotics.

Source: USDA, Economic Research Service estimates using 2012-17 IRI Consumer Network data, Label Insight, USDA, Food Safety and Inspection Service Label Submission and Approval System data, and independent label data collection.

We segmented the uniform-weight chicken market into three distinct categories (figure 4). The classic chicken segment includes raw, minimally processed chicken products (fresh or frozen), for example, frozen raw chicken breasts with a predefined weight. The processed chicken segment includes all chicken products that are cooked, marinated, breaded, fried, etc. Lastly, the chicken sausage segment includes all chicken sausage products. Although chicken sausage is a relatively small market segment, it is almost always sold in uniform-weight packages, minimizing the issue of random-weight exclusion. We further segmented each of these markets into three mutually exclusive categories based on their labels: conventional, RWA, and organic (with the understanding that organic products are also RWA but with additional production requirements).

Figure 4
Expenditure shares of uniform-weight chicken products by classic, processed, and sausage market segments, 2012–17



Notes: Uniform-weight chicken products are sold and priced at the item level in uniform weights. Shares include all uniform-weight chicken products, including those labeled raised without antibiotics (RWA) and organic.

Source: USDA, Economic Research Service estimates using 2012–17 IRI Consumer Network data.

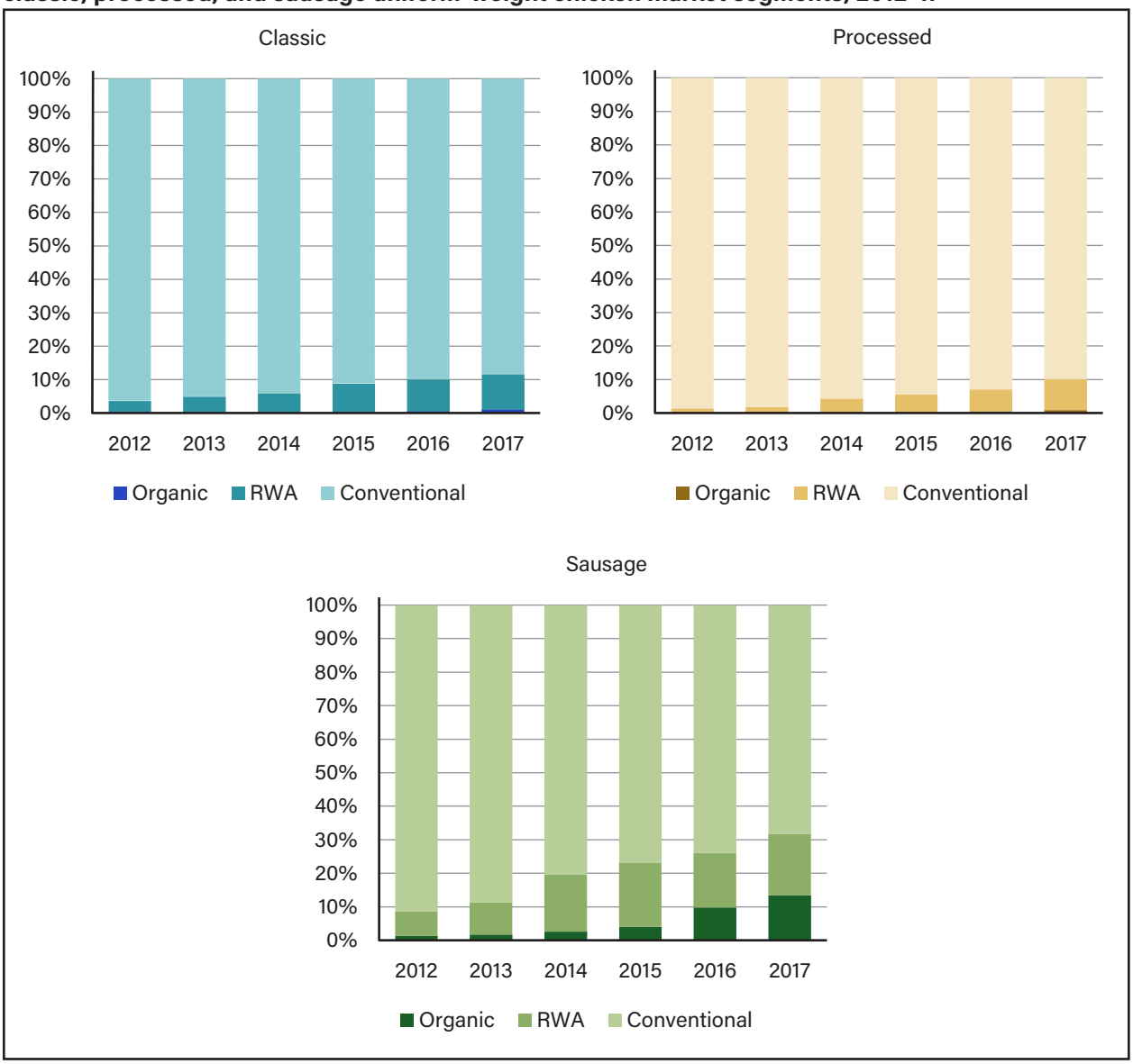
Market Shares and Prices

Having identified RWA and organic claims on uniform-weight chicken products across the defined market segments (classic, processed, and sausage), we then estimated the market shares for each claim (RWA and organic) within each market segment using the IRI Consumer Network purchase data and projection factors (figure 5). Market shares were defined as the percent of total dollar expenditures. Across all three market segments, market shares for uniform-weight chicken products labeled RWA grew substantially from year to year. In 2012, RWA-labeled products represented only 4 percent of the classic market, 1 percent of the processed market, and 7 percent of the sausage market. However, by 2017, RWA-labeled products represented 11, 9, and 18 percent of the markets, respectively.[8] Interestingly, over the same period, the market shares for organic products remained consistently low for classic and processed uniform-weight chicken products (representing 0 to 1 percent of the market), but grew from 1 to 13 percent of the chicken sausage market.

[8]These expenditure figures are considerably different than the production shares reported by USDA, Agricultural Marketing Service (AMS) (table 2). However, the USDA, AMS production shares represent all broiler production (i.e., retail, foodservice, and institutional), whereas the estimated market shares here only represent grocery retail purchases.

Figure 5

Market shares of expenditures for raised without antibiotics (RWA) and organic claims within classic, processed, and sausage uniform-weight chicken market segments, 2012–17



Note: Organic market shares in the classic and processed market segments are less than or equal to 1 percent.

Source: USDA, Economic Research Service estimates using 2012–17 IRI Consumer Network data and projection weights; Label Insight; USDA, Food Safety and Inspection Service Label Submission and Approval System data, and independent label data collection.

Average prices per pound (in 2017 dollars) were also calculated across all three market segments using the IRI Consumer Network data and projection factors (figure 6).[9] Predictibly, classic, unprocessed chicken products were generally cheaper than processed chicken products (including sausage). Across all three market segments, prices for conventional chicken products were generally stable across all 6 years (approximately $2.35 per pound for classic products, $4.05 per pound for processed products, and $5.14 per pound for sausage products), whereas prices for RWA and organic-labeled products experienced more volatility. However, as revealed by figure 5, RWA and organic products represented a relatively small part of the market, and therefore, any average price estimates for these products would inherently include more noise.

[9]Prices were deflated using the Consumer Price Index for all urban consumers (CPI-U) for chicken.

Figure 6

Average prices per pound for uniform-weight chicken products labeled raised without antibiotics (RWA) and organic within classic, processed, and sausage chicken market segments, 2012–17

Note: Prices presented in 2017 dollars.

Source: USDA, Economic Research Service estimates using 2012-17 IRI Consumer Network data and projection weights, Label Insight, USDA, Food Safety and Inspection Service Label Submission and Approval System data, and independent label data collection.

Both the classic and processed chicken market segments demonstrated a similar pricing hierarchy, in that organic prices were greater than RWA prices, which were greater than conventional prices. For classic chicken products, the average difference in price from 2012 to 2017 between conventional and RWA-labeled products was $2.04 per pound (87 percent).[10] For processed products, the average difference was $2.23 per pound (55 percent). While organic prices were only marginally greater than RWA prices in the classic chicken market

[10]The difference in price between conventional and RWA-labeled classic chicken products is in line with a previous estimate of 80 percent using USDA, AMS data for boneless and skinless chicken breasts (Kuchler et al., 2017b).

segment (with the exception of 2012),[11] prices for organic processed chicken products on average commanded an additional $2.90 per pound over RWA-labeled processed chicken products, representing a 125-percent total markup over conventionally processed chicken products.

Prices in the chicken sausage market segment followed a similar pricing hierarchy until 2015 when organic prices dropped below those of RWA-labeled products (though both still remained greater than conventional products). The drop in organic prices was likely related to the expansion of organic chicken sausage products during this time. Total expenditures for organic chicken sausage were 11 times greater in 2017 than they were in 2012, whereas total expenditures for RWA chicken sausage increased by a magnitude of 2.8 during this time. Additionally, the number of organic chicken sausage products purchased by Consumer Network households more than tripled between 2012 and 2017 (increasing from 18 to 57). The sharpest increase was between 2014 and 2015 when the number of products nearly doubled (increasing from 23 to 42). The more products that become available on the market, the more likely it is that prices become competitive and drop. Moreover, the chicken sausage market was relatively small. It was included as a point of comparison because these products are almost always sold in uniform-weight packages, thereby minimizing the issue of excluding random-weight products from the analysis.

[11]The average difference in price from 2012 to 2017 between conventional and organic classic products was $3.42 per pound (145 percent), slightly lower than a previous estimate of 170 percent using AMS data for boneless and skinless chicken breasts (Kuchler et al., 2017b). Notably, the real average price for organic classic chicken products fell substantially between 2012 and 2013, from $8.69 per pound to $5.16 per pound. We suspect this is an issue of volume purchased. While overall the market share for classic organic chicken products remained low during these 6 years (representing less than 1 percent of the market), expenditures on organic products still grew substantially from year to year. From 2012 to 2013, total expenditures for classic uniform-weight organic chicken products increased nearly four-fold. By 2017, total expenditures were 18 times what they were in 2012.

Households That Purchased Chicken Products Labeled Raised Without Antibiotics

Another important analysis for understanding the market growth of products labeled RWA is to identify and characterize the consumers who purchase RWA-labeled chicken products, observing whether any significant demographic differences exist between those who purchase RWA-labeled products and those who do not purchase them. For the purposes of comparison, we considered three sets of households: (1) households that purchased at least one organic chicken product, (2) households that purchased at least one RWA-labeled chicken product (but not an organic product), and (3) households that only purchased conventional chicken products in 2017.[12] It is important to note, however, that for non-purchasing households of RWA and organic, we could not distinguish between product unavailability and a deliberate non-purchase decision when products were available.

Table 3 presents selected demographic factors for these three sets of households and the full panel of static households that purchased at least one chicken product in 2017. Consistent with observed higher price premiums for these products, the median household income range was significantly greater for households that purchased organic and RWA-labeled chicken.[13] Households that purchased organic and RWA-labeled chicken were also marginally larger and more likely to have children present in the household.

[12]Of the households that purchased at least one RWA-labeled chicken product (but not organic) in 2017, 89 percent purchased both RWA-labeled and conventional chicken products and 12 percent only purchased RWA-labeled chicken products. Of the households that purchased at least one organic chicken product in 2017, 47 percent purchased both conventional and organic chicken products, 5 percent purchased both RWA-labeled and organic chicken products, 39 percent purchased all three types of chicken products, and 10 percent purchased only organic chicken products.

[13]Household income is reported by IRI as a categorical variable, not a continuous variable.

Table 3
Selected 2017 household demographics of chicken purchasers

	Conventional shoppers	Raised Without Antibiotics shoppers	Organic shoppers	Full static panel
Median household income	$50,000-59,999	$70,000-99,999**	$70,000-99,999**	$50,000-59,999
Average household size	2.67	2.87**	2.93**	2.73
Female primary shopper (%)	79.40	82.11**	80.61	80.03
Education of primary shopper				
No degree (%)	2.40	1.42**	1.04**	2.13
High school degree (%)	51.16	44.08**	39.60**††	49.12
College degree (%)	46.44	54.50**	59.35**††	48.75
Presence of children				
Children under 18 (%)	35.13	43.02**	45.50**	37.29
Children under 6 (%)	15.68	20.80**	21.35**	17.03
Sample size (n)	37,006	10,300	2,218	49,524

Note: Asterisk (*) and double asterisk (**) indicate statistically significant differences from conventional shoppers at the 5- and 1-percent levels, respectively. Similarly, dagger (†) and double dagger (††) indicate statistically significant differences between raised without antibiotics (RWA) shoppers and organic shoppers at the 5- and 1-percent levels, respectively. Household income is reported by IRI as a categorical variable, not a continuous variable. Mean household size may be biased downwards because the number of reported individuals per household is capped at eight. However, households of 8 or more members only account for 0.50 percent of the 2017 static household panel. Lastly, the education of the primary shopper was unavailable for one household.

Source: USDA, Economic Research Service calculations using 2017 IRI Consumer Network data and projection weights, Label Insight, USDA, Food Safety and Inspection Service Label Submission and Approval System data, and independent label data collection.

Within each household, IRI identifies the primary food shopper and meal preparer. For households that purchased RWA-labeled chicken products, the primary food shopper was slightly more likely to be female. Households that purchased RWA-labeled chicken products were also more likely to have a primary food shopper with a college degree as compared to households that only purchased conventional chicken products. Education was the only demographic factor where there was also a statistically significant difference between RWA-purchasing households and organic-purchasing households. That is, an even greater share of households that purchased organic had a primary food shopper with a college degree (59 percent versus 55 percent).

Starting in 2016, a subset of the Consumer Network began to fill out a MedProfiler survey that included a question gauging consumer concern about antibiotic use in meat production. Individual respondents could indicate they were very concerned, somewhat concerned, or not at all concerned about antibiotic use in meat production. Table 4 presents the reported level of concern for conventional, RWA, and organic shoppers in 2017. Of significance, 32 percent of households that purchased organic chicken products and 26 percent that purchased RWA-labeled chicken products reported they were very concerned about antibiotic use in meat production, compared to the 21 percent that only purchased conventional chicken. The inverse relationship

held true among those stating they were not at all concerned about antibiotic use in meat production. These sizable and significant differences suggest that consumer concerns and perceptions of risk play a large and important role in purchasing decisions. That is, consumers who bought RWA or organic chicken products were more likely to report being concerned about antibiotic use than those who did not buy them.

Table 4
Consumer concern of antibiotic use in meat production, (percent)

	Conventional shoppers	Raised Without Antibiotics shoppers	Organic shoppers
Very concerned	21.07	25.65**	31.94**††
Somewhat concerned	34.68	34.67	32.95
Not at all concerned	44.25	39.68**	35.11**††
Sample size (n)	22,909	6,605	1,470

Note: Asterisk (*) and double asterisk (**) indicate statistically significant differences from conventional shoppers at the 5- and 1-percent levels, respectively. Similarly, dagger (†) and double dagger (††) indicate statistically significant differences between raised without antibiotics (RWA) shoppers and organic shoppers at the 5- and 1-percent levels, respectively. One household that completed the MedProfiler survey but did not respond to this question was dropped from the analysis.

Source: USDA, Economic Research Service calculations using 2017 IRI Consumer Network, MedProfiler data, and projection weights, Label Insight, USDA, Food Safety and Inspection Service Label Submission and Approval System data, and independent label data collection.

Discussion

Consumer interest in animal products raised without antibiotics has grown considerably over the past decade. This report examines the extent of that growth by estimating market shares and prices of chicken products labeled RWA between 2012 and 2017 and by characterizing the demographics of households that purchased RWA-labeled chicken products. To do this, we analyzed proprietary household-level scanner data from IRI merged with a novel dataset of poultry product label claims compiled from multiple sources, including Label Insight and the USDA, FSIS LSAS.

Between 2012 and 2017, respondents participating in the IRI Consumer Network purchased nearly 400 different uniform-weight chicken products labeled RWA. We segmented these products into three different markets: classic, processed, and sausage. Over these 6 years, household expenditure shares for RWA-labeled products in these market segments grew steadily by 7, 8, and 11 percent, respectively. RWA-labeled products also commanded higher prices than conventional uniform-weight chicken products. From 2012 to 2017, the average price per pound difference between conventional and RWA-labeled chicken products in each market segment (classic, processed, and sausage) was $2.04, $2.23, and $2.48, respectively. Additionally, households that purchased RWA-labeled chicken products were on average larger with a greater likelihood of children present, had higher incomes, and were more likely to have a female primary food shopper and primary food shopper with a college degree. Lastly, consumers who bought RWA-labeled chicken products were more likely to report being very concerned about antibiotic use in meat production than those who did not buy them.

USDA-certified organic chicken products are also raised without antibiotics, but they are subject to additional production requirements, including organic feed and year-round access to the outdoors. These products exhibited little market growth over these 6 years (with the exception of chicken sausage) and generally commanded even higher prices. These findings suggest significant consumer interest and market opportunities for production practices somewhere between conventional and the stringent standards of organic practices.

One caveat is that the estimated household expenditure shares were considerably different from the production shares reported by USDA, Agricultural Marketing Service (AMS) in 2016 and 2017 (table 2). At least part of the difference can be attributed to retail channels. The AMS production share data include broilers produced for all retail channels, including foodservice and institutional outlets. In recent years, several major foodservice chains, including Panera, Chipotle, and Chick-fil-A, have pledged to sell only meat products raised without antibiotics (Consumer Reports, 2015). However, the animal products sold at these chains are not labeled RWA when purchased by the final consumer, and they are not captured in the Consumer Network data. In other words, foodservice retailers have become major customers of RWA chicken products, which may account for part of the difference between the AMS estimates and IRI Consumer Network estimates. Another possibility that may account for part of the difference is that a share of broilers may have been raised without antibiotics but not labeled as such in commerce because the producer did not deem it profitable to do so.

While the present analysis captures market shares and average prices of products labeled RWA, it does not capture consumer willingness to pay for such products. Future work can estimate price premiums specific to RWA labels and account for other labels and attributes that may be present on poultry products, including brand, organic, natural, no added hormones, free range, vegetarian-fed, etc. It remains unclear how consumers interpret each of these labels and the marginal value or confusion that each label introduces.

References

Barrow, P.A., M.A. Jones, A.L. Smith, and P. Wigley, 2012, "The long view: Salmonella – the last forty years," Avian Pathology, 41(5):413-20.

Bentley, J. 2012. U.S. Per Capita Availability of Chicken Surpasses That of Beef, Amber Waves, U.S. Department of Agriculture, Economic Research Service.

Bowman, M., K.K. Marshall, F. Kuchler, and L. Lynch. 2016. "Raised Without Antibiotics: Lessons from Voluntary Labeling of Antibiotic Use Practices in the Broiler Industry," American Journal of Agricultural Economics 98(2): 622-42.

Brewer, M.S., and M. Rojas. 2008. "Consumer Attitudes Toward Issues in Food Safety," Journal of Food Safety, 28(1):1-22.

Callaway, T.R., T.S. Edrington, J.L. Rychlik, K.J. Genovese, T.L. Poole, Y.S. Jung, K.M. Bischoff, R.C. Anderson, and D.J. Nisbet. 2003. "Ionophores: Their Use as Ruminant Growth Promotants and Impact on Food Safety," Current Issues in Intestinal Microbiology 4(2):43-51.

Carlson, A. and E. Jaenicke. 2016. Changes in Retail Organic Price Premiums from 2004 to 2010, ERR-209, U.S. Department of Agriculture, Economic Research Service.

Castillo-Neyra, R., J.A. Frisancho, J.L. Rinsky, C. Resnick, K.C. Carroll, A.M. Rule, T. Ross, Y. You, L.B. Price, and E.K. Silbergeld. 2014. "Multidrug-Resistant and Methicillin-Resistant Staphylococcus Aureus (MRSA) in Hog Slaughter and Processing Plant Workers and Their Community in North Carolina (USA)," Environmental Health Perspectives 122(4):471-77.

Chang, Q., W. Wang, G. Regev-Yochay, M. Lipsitch, and W.P. Hanage. 2015. "Antibiotics in agriculture and the risk to human health: how worried should we be?" Evolutionary Applications 8(3):204-47.

Charles, D. 2016. "Perdue Goes (Almost) Antibiotic-Free." NPR (National Public Radio), October 7.

Chee-Sanford, J.C., R.I. Mackie, S. Koike, I.G. Krapac, Y.F. Lin, A.C. Yannarell, S. Maxwell, and R.I. Aminov. 2009. "Fate and Transport of Antibiotic Residues and Antibiotic Resistance Genes Following Land Application of Manure Waste," Journal of Environmental Quality 38(3):1086-108.

Chen, Y., S. Mukherjee, M. Hoffmann, M.L. Kotewicz, S. Young, J. Abbott, Y. Luo, M.K. Davidson, M. Allard, P. McDermott, and S Zhao. 2013. "Whole-Genome Sequencing of Gentamicin-Resistant Campylobacter Coli Isolated from U.S. Retail Meats Reveals Novel Plasmid-Mediated Aminoglycoside Resistance Genes," Antimicrobial Agents and Chemotherapy 57(11):5398-405.

Consumer Reports. 2015. Chain Reaction: Hot Top Restaurants Rate on Reducing Use of Antibiotics in Their Meat Supply.

Davies, J., and D. Davies. 2010. "Origins and Evolution of Antibiotic Resistance," Microbiology and Molecular Biology Reviews 74(3):417-33.

Fancher, C.A., L. Zhang, A.S. Kiess, P.A. Adhikari, T.T.N. Dinh, and A.T. Sukumaran. 2020. "Avian Pathogenic Echerichia coli and Clostridium perfringens: Challenges in No Antibiotics Ever Broiler Production and Potential Solutions," Microorganisms 8(10):1533.

Ge, B., F. Wang, M. Sjölund-Karlsson, and P.F. McDermott. 2013. "Antimicrobial Resistance in Campylobacter: Susceptibility Testing Methods and Resistance Trends," Journal of Microbiological Methods 95(1):57-67.

Kuchler, F., C. Greene, M. Bowman, K. Marshall, J. Bovay, and L. Lynch. 2017a. Beyond Nutrition and Organic Labels – 30 Years of Experience With Intervening in Food Labels, ERR-239, U.S. Department of Agriculture, Economic Research Service.

Kuchler, F., C. Greene, M. Bowman, K. Marshall, J. Bovay, and L. Lynch. 2017b. Federal Nutrition and Organic Labels Paved the Way for Single-Trait Label Claims, Amber Waves, U.S. Department of Agriculture, Economic Research Service.

Levin, D., D. Noriega, C. Dicken, A. Okrent, M. Harding, and M. Lovenheim. 2018. Examining Store Scanner Data: A Comparison of the IRI Infoscan Data With Other Data Sets, 2008-12, TB-1949, U.S. Department of Agriculture, Economic Research Service.

MacDonald, J.M. 2014. Technology, Organization, and Financial Performance in U.S. Broiler Production, EIB-126, U.S. Department of Agriculture, Economic Research Service.

Marshall, B.M., and S.B. Levy. 2011. "Food Animals and Antimicrobials: Impacts on Human Health," Clinical Microbiology Reviews 24(4):718-33.

Marti, R., A. Scott, Y.C. Tien, R. Murray, L. Sabourin, Y. Zhang, and E. Topp. 2013. "Impact of Manure Fertilization on the Abundance of Antibiotic-Resistant Bacteria and Frequency of Detection of Antibiotic Resistance Genes in Soil and on Vegetables at Harvest," Applied and Environmental Microbiology 79(18):5701-09.

McEwen, S.A., and P.J. Fedorka-Cray. 2002. "Antimicrobial Use and Resistance in Animals," Clinical Infectious Diseases 34(Supplement 3):S93-S106.

Mellon, M., C. Benbrook, and K.L. Benbrook. 2001. Hogging It: Estimates of Antimicrobial Abuse in Livestock, Union of Concerned Scientists.

Messer, K.D., M. Costanigro, and H.M. Kaiser. 2017. "Labeling Food Processes: The Good, the Bad and the Ugly," Applied Economic Perspectives and Policy 39(3):407-27.

Muth, M.K., M. Sweitzer, D. Brown, K. Capogrossi, S. Karns, D. Levin, A. Okrent, P. Siegel, and C. Zhen. 2016. Understanding IRI Household-Based and Store-Based Scanner Data, TB-1942, U.S. Department of Agriculture, Economic Research Service.

National Research Council. 1999. The Use of Drugs in Food Animals: Benefits and Risks. Washington, D.C.: National Academy Press.

Pew Charitable Trusts. 2008. Putting Meat on the Table: Industrial Farm Animal Production in America, A Report of the Pew Commission on Industrial Farm Animal Production, A Project of The Pew Charitable Trusts and Johns Hopkins Bloomberg School of Public Health.

Price, L.B., J.P. Graham, L.G. Lackey, A. Roess, R. Vailes, and E.K. Silbergeld. 2007. "Elevated Risk of Carrying Gentamicin-Resistant Escherichia Coli Among U.S. Poultry Workers," Environmental Health Perspectives 115(12):1738-42.

Rinsky, J.L., M. Nadimpalli, S. Wing, D. Hall, D. Baron, L.B. Price, J. Larsen, M. Stegger, J. Stewart, and C.D. Heaney. 2013. "Livestock-Associated Methicillin and Multidrug Resistant Staphylococcus Aureus Is Present among Industrial, Not Antibiotic-Free Livestock Operation Workers in North Carolina," PLoS One 8(7):e67641.

Rule, A.M., S.L. Evans, and E.K. Silbergeld. 2008. "Food Animal Transport: A Potential Source of Community Exposures to Health Hazards from Industrial Farming (CAFOs)," Journal of Infection and Public Health 1(1):33-39.

Shaffer, E. 2017. "A Closer Look at Tyson's No-Antibiotics Commitment." Meat + Poultry, November 1.

Sjölund-Karlsson, M., R.L. Howie, K. Blickenstaff, P. Boerlin, T. Ball, G. Chalmers, B. Duval, J. Haro, R. Rickert, S. Zhao, and P.J. Fedorka-Cray. 2013. "Occurrence of lactamase Genes Among Non-Typhi Salmonella Enterica Isolated from Humans, Food Animals, and Retail Meats in the United States and Canada," Microbial Drug Resistance 19(3):191-97.

Smith, T.C., W.A. Gebreyes, M.J. Abley, A.L. Harper, B.M. Forshey, M.J. Male, H.W. Martin, B.Z. Molla, S. Sreevatsan, S. Thakur, M. Thiruvengadam, and P.R. Davies. 2013. "Methicillin-Resistant Staphylococcus Aureus in Pigs and Farm Workers on Conventional and Antibiotic-Free Swine Farms in the USA," PLoS One 8(5):e63704.

Sneeringer, S., M. Bowman, and M. Clancy. 2019. The U.S. and EU Animal Pharmaceutical Industries in the Age of Antibiotic Resistance, ERR-264, U.S. Department of Agriculture, Economic Research Service.

Sneeringer, S., J. MacDonald, N. Key, W. McBride, and K. Mathews. 2015. Economics of Antibiotic Use in U.S. Livestock Production, ERR-200, U.S. Department of Agriculture, Economic Research Service.

Sweitzer, M., D. Brown, S. Karns, M.K. Muth, P. Siegel, and C. Zhen. 2017. Food-at-Home Expenditures: Comparing Commercial Household Scanner Data from IRI and Government Survey Data, TB-1949, U.S. Department of Agriculture, Economic Research Service.

U.S. Centers for Disease Control and Prevention (CDC). 2013. Antibiotic Resistance Threats in the United States, 2013.

U.S. Centers for Disease Control and Prevention (CDC). 2019. Antibiotic Resistance Threats in the United States, 2019.

U.S. Department of Agriculture (USDA), Economic Research Service (ERS). Food Availability (Per Capita) Data System.

U.S. Department of Agriculture (USDA), Food Safety and Inspection Service (FSIS). 2015. User Guide for Industry Users - Label Submission and Approval System.

U.S. Department of Agriculture (USDA), Food Safety and Inspection Service (FSIS). 2017. FSIS Compliance Guideline for Label Approval.

U.S. Department of Agriculture (USDA), Food Safety and Inspection Service (FSIS). 2019. FSIS Labeling Guideline on Documentation Needed to Substantiate Animal Raising Claims for Label Submissions.

U.S. Department of Agriculture (USDA), National Agricultural Statistics Service (NASS). 2018. Poultry Slaughter 2017 Summary.

U.S. Food and Drug Administration (FDA). 2012. Guidance for Industry #209: The Judicious Use of Medically Important Antimicrobial Drugs in Food-Producing Animals.

U.S. Food and Drug Administration (FDA). 2012. Guidance for Industry #213: New Animal Drugs and New Animal Drug Combination Products Administered in or on Medicated Feed or Drinking Water of Food-Producing Animals: Recommendations for Drug Sponsors for Voluntarily Aligning Product Use Conditions with GFI #209.

WATT Poultry USA. 2018. WATT Poultry USA's 2018 Top Broiler Companies. March edition.

Wellington, E.M., A.B. Boxall, P. Cross, E.J. Feil, W.H. Gaze, P.M. Hawkey, A.S. Johnson-Rollings, D.L. Jones, N.M. Lee, W. Otten, and C.M. Thomas. 2013. "The Role of the Natural Environment in the Emergence of Antibiotic Resistance in Gram-Negative Bacteria," The Lancet Infectious Diseases 13(2):155-65.

World Health Organization (WHO), Interagency Coordination Group on Antimicrobial Resistance. 2019. No Time to Wait: Securing the Future from Drug-Resistant Infections.

Zhao, S., S. Mukherjee, Y. Chen, C. Li, S. Young, M. Warren, J. Abbott, S. Friedman, C. Kabera, M. Karlsson, and P.F. McDermott. 2015. "Novel Gentamicin Resistance Genes in Campylobacter Isolated from Humans and Retail Meats in the USA," Journal of Antimicrobial Chemotherapy 70(5):1314-321.