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# Factors Affecting Wholesale Poultry Prices

Joe L. Parcell and Vern Pierce

## ABSTRACT

Changes in consumer demand for poultry meats can be characterized as evolving over time and following seasonal patterns. The focus of this study is on understanding factors affecting wholesale poultry prices. This information is needed so that poultry processors and poultry producers may better understand how consumer purchasing patterns affect price changes. Results suggest that seasonal differences between the price of cuts exist. Furthermore, own-cut and cross-cut flexibilities were unique to individual cuts.

**Key Words:** *turkey primals, chicken primals, inverse demand model.*

A marketing system is an ever-evolving mechanism for exchanging information. Producers and industry personnel have difficulty assimilating this information. One of the many goals of a marketing system is to mitigate price risk. Price risk accumulates from changes in production and consumer preferences over time, i.e., change in supply or demand. The demand for poultry products is ever changing as beef and pork are constantly competing for market share. The poultry industry has attempted to mitigate production risk, i.e., supply-side risk, through vertical coordination so that changes in production quantity and quality can effectively occur in response to changes in consumer demand. Through vertical coordination the poultry industry has attempted to "lock-in" one side of the farm-retail margin. Wholesale price is one aspect of poultry demand that can be analyzed to help mitigate price risk. The focus of this study is to gain an understanding of the factors that cause fluctuations in wholesale poultry prices so that processors, retailers, and producers can better manage price risk.

No previous research has investigated factors affecting wholesale poultry price vari-

ability. However, Bernard and Willett concluded, "... concentration and power of the integrators in the [poultry] industry have allowed the wholesale price to become the center, causal price in the market" (p.729). Additionally, as per-capita poultry consumption continues to increase in absolute terms and relative to beef and pork, there is a need to better understand the demand drivers in the poultry industry. Specifically, research is needed to quantify factors affecting demand for wholesale poultry products and the seasonal fluctuations in prices.

Previous research, e.g., Aradhyula and Holt; Bernard and Willett; Chavas and Johnson; Goodwin, Madrigal, and Martin; and Karpombe and Colyer, has, however, focused primarily on modeling dynamic supply responses in the broiler industry. Chavas and Johnson and Aradhyula and Holt concluded that broiler supply responded to changes in wholesale price, feed costs, and broiler hatches. Bernard and Willett used Granger Causality test statistics to determine factors causing price responses in the farm, wholesale, and retail broiler markets. Bernard and Willett found that wholesale price Granger caused farm prices, and farm and wholesale prices Granger caused retail prices; however, neither farm price, retail

price, nor gasoline price used as a proxy for transportation costs Granger caused wholesale price changes.

Some poultry grower contracts have a built-in price floor, and payments above the price floor are dependent on the weighted average wholesale price of either broiler or turkey cuts. For example, assume a contract has a price floor of 36¢ per pound. Now, assume the contract is designed such that the producer will receive either the greater of the floor price or 80 percent of the weighted average wholesale price less a 15¢-per-pound processing fee. Thus, if the weighted average wholesale price for the bird cuts is 60¢ per pound, the potential payment would be 60¢ per pound  $\times$  80 percent less 15¢-per-pound processing fee or 33¢-per-pound contract value. Therefore, in this scenario the contract grower would receive the floor price because the calculated value is below the floor price. Additionally, for computed values above the price floor the producer would receive some predetermined portion of the difference between the wholesale derived farm price and price floor. By understanding factors affecting wholesale broiler or turkey cut prices, producers and processors can better assess the market situation.

### Empirical Model

The wholesale poultry price is determined by the derived demand for retail poultry cuts and derived supply of broilers or turkeys. Because more than a month, the periodicity of the data evaluated in this study, is required to change the production of either broilers or turkeys it is assumed that supply is exogenous. Thus, given that the wholesale cut price is endogenous, the specification of the inverse demand model for factors anticipated to affect the wholesale price ( $P_{jit}$ ) of poultry type  $j$  ( $j$  = broilers and turkeys) and cut  $i$  ( $i$  = boneless breasts, ribbed breasts, drumsticks, leg quarters, and wings for  $j$  = broilers; and  $i$  = toms, hens, drumsticks, wings, and breasts for  $j$  = turkeys) in month  $t$  is:

$$(1) \quad P_{jit} = f(P_{jit-1}, QBR_t, QT_t, QB_t, QP_t, MONTH_t, IMC_t).$$

The one-period lagged wholesale cut price ( $P_{t-1}$ ) is included in the model to capture the between-month price inertia (Nerlove). These coefficients are expected to be positive and coefficients are expected to lie between zero and unity.<sup>1</sup> Capps *et al.* found that most of the lagged dependent variables for different wholesale beef cut prices were statistically significant. The ratio of own-price flexibility to the coefficient of adjustment can be used to calculate long-run own-price flexibilities for each cut as will be discussed later.

In evaluating the factors affecting alternative cuts of beef, Capps *et al.* partitioned wholesale beef production into own-quantity and an aggregated cross-quantity value of all other cuts of beef analyzed. Capps *et al.* used a USDA wholesale yield factor for each separate cut by multiplying the own-quantity and cross-quantity factors with beef production. However, for the current analysis, fixed proportions of carcass yield are assumed for both broilers and turkeys due to the lack of variability between cut yields over the period evaluated in the study. Own-quantity per-capita consumption of broiler meat ( $QBR$ ) and per-capita consumption of turkey ( $QBT$ ) are included in the inverse demand models. Following conventional theory, an increase in own-quantity consumption for the wholesale cut equation of either chicken or turkey is expected to have a negative impact on price for each poultry cut evaluated. Turkey or broiler consumption as a cross-quantity variable is expected to have a negative impact on the wholesale cut price because of consumers alternating between chicken and turkey.

The model includes per-capita consumption of beef ( $QB$ ) and per-capita consumption of pork ( $QP$ ). These cross-quantities are included because of the substitutability between individual cuts of poultry and pork and beef. Thus it is expected that an increase in either of these variables would lead to a reduction in the wholesale cut price.

<sup>1</sup> Each price series was tested for the presence of a unit root using the Dickey-Fuller unit root test statistic. For each price series, the null-hypothesis of a unit root was rejected.

Capps *et al.* included an index of marketing costs in explaining factors affecting wholesale beef cuts. Capps *et al.* hypothesized that an increase in marketing costs would lead to an increase in the wholesale cut price. Therefore, an index of marketing costs (IMC) was included in the wholesale broiler and turkey cuts models, and an increase in marketing costs is expected to increase wholesale turkey and broiler prices.

The wholesale price is determined by the demand for retail products by the consumer and supply of live broilers or turkeys, so monthly binary variables (*MONTH*) are included in the model to capture seasonal trends of poultry consumption and changes in consumer preferences and attitudes. Kapombe and Colyer found that there was little evidence to support recent seasonal broiler production. Thus estimated coefficients for the monthly variables are intercept shift variables that likely indicate changes in demand throughout the year. December is chosen as the default. There is no *a priori* expectation on seasonal effects for an individual broiler or turkey cut.

Given that broiler and turkey supplies are assumed exogenous to the model and that exogenous factors such as consumer perception and industry concentration would impact individual broiler or turkey prices similarly, broiler and turkey cuts are estimated separately as a system of equations. Seemingly unrelated regression (SUR) analysis improves estimation efficiency when cross-equation errors are contemporaneously correlated (Greene). In addition to contemporaneous correlation, when using time-series data, residual autocorrelation may be a concern. Because of the presence of a lagged dependent variable, the Durbin-*h* statistic was calculated to test for the presence of autocorrelation in each of the wholesale cut equations. The null-hypothesis of no autocorrelation was only rejected for broiler wings. Therefore, both the broiler and turkey systems were corrected for autocorrelation by allowing the autocorrelation value to vary across wholesale cut equations within the system.

The SUR procedure for the five wholesale cuts of either broilers or turkeys using equa-

tion 1 was estimated using the non-linear systems commands in *SHAZAM* 8.0. The models were estimated in double-log form. Thus estimated parameters refer to price flexibilities. Additionally, because the log of the monthly dummy values cannot be computed, estimated coefficients were transformed to a percentage change relative to the default month using the formulation  $(e^{\beta_1} - 1) \times 100$ . The following section describes the data used to estimate the inverse demand equations for the different wholesale cut prices of broilers and turkeys.

## Data

Summary statistics of selected variables are listed in Table 1. This analysis uses monthly data for April 1988 through December 1997. Nominal prices of wholesale cuts of broilers are weekly U.S. aggregate prices obtained from issues of the *Poultry Yearbook Summary*. Weekly wholesale cut prices for broilers were aggregated to monthly averages. Nominal prices of wholesale cuts of turkeys are monthly U.S. aggregate prices obtained from monthly publications of the *Livestock, Dairy, and Poultry Situation and Outlook* (USDA). Various wholesale turkey cut prices were occasionally missing. These prices were estimated by employing step-wise regression of the price series containing missing values as a function of prices of all other cuts of meat from the same species included in the data set to determine the price series which had the largest correlation with the regressor. Each data series of prices was deflated by the monthly Producer Price Index for wholesale food and feed goods (1997 = 100).

Per-capita consumption of beef and pork was calculated by dividing monthly pounds of production by the U.S. resident population (United States Department of Commerce). Weekly production data for beef and pork were obtained from the *Livestock, Meat, and Wool Weekly Summary Statistics* (USDA). Weekly production data for pork and beef were aggregated to monthly. Monthly total U.S. production was modified by adding monthly imports, subtracting monthly exports, and subtracting the change in the level of cold

**Table 1.** Descriptive Statistics of Variables Used in the Estimation of Equation 1 (115 Monthly Observations, April 1987–December 1997)

Variable	Mean	Standard Deviation	Minimum	Maximum
Wholesale Broiler Price (\$/lb)				
Boneless breast	2.32	0.65	1.44	4.17
Ribbed breasts	1.11	0.29	0.68	1.99
Drumsticks	0.42	0.07	0.29	0.56
Leg quarters	0.35	0.07	0.24	0.57
Wings	0.62	0.13	0.40	0.90
Wholesale Turkey Price (\$/lb)				
Toms	0.69	0.07	0.54	0.97
Hens	0.68	0.07	0.56	0.93
Drumsticks	0.32	0.06	0.18	0.53
Wings	0.30	0.06	0.17	0.46
Breasts	1.09	0.15	0.92	1.68
Production (lbs/person/month) <sup>a</sup>				
Beef	7.545	0.932	5.385	9.427
Broilers	9.720	1.648	6.833	13.753
Pork	5.258	0.889	3.866	7.194
Turkeys	1.951	0.549	1.128	3.894
Index of marketing costs (1997 = 100) <sup>b</sup>				
	70.95	2.75	66.50	77.85

<sup>a</sup> Per-capita production adjusted for exports, imports, and changes in cold storage stocks.

<sup>b</sup> The index of marketing costs was calculated as the simple average of the meat packing plant wage rate and energy producer price index.

storage stocks between months. Weekly data were aggregated to monthly for this computation. Because import, export, and cold storage quantities are processed quantities, these data were converted to a live-weight equivalent. Weekly production data for broilers and turkeys were available from publications of the *Poultry Yearbook Summary*. Weekly production data for beef, pork, chicken, and turkey were aggregated to monthly data and adjusted for exports and between month changes in cold storage stocks. The U.S. resident population data are monthly (U.S. Department of the Census). Domestic exports and imports of beef, broiler meat, pork, and turkey meat data were obtained from the *Livestock, Dairy, and Poultry Situation and Outlook* (USDA). Cold storage data for beef, broiler meat, pork, and turkey were obtained from USDA *Cold Storage* reports.

The index of marketing costs was calculated as the simple average of the meat packing plant wage rate and energy producer price in-

dex (Bureau of Labor Statistics). The monthly marketing cost index was deflated by the monthly Consumer Price Index (1997 = 100).

## Results

Table 2 reports estimation results for variables other than seasonal intercept shifters. Parameter estimates reported in Table 2 are flexibilities. The coefficients represent percentage changes. The inverse demand models explained between 88 percent and 96 percent of the variation in wholesale broiler cut prices, and for turkey, between 71 percent and 87 percent of the variation in wholesale price cuts were explained. The *rho* coefficient used to correct data for autocorrelation is reported in the final column of Table 2.

The coefficient of adjustment (lagged dependent) variable was positive and was within the unit interval for all of the wholesale price cuts evaluated. The variable was statistically significant for all poultry cuts. Generally,

Table 2. Estimation Results of Determinants of Wholesale Poultry Cut Prices (Dependent Variable is Wholesale Cut Price).

Wholesale Cut Price	Constant	Own-Cut Flexibility (SR)	Lagged Dep.	Own-Cut Flexibility (LR)	Cross-Product Flexibility (Beef)	Cross-Product Flexibility (Pork)	Cross-Product Flexibility (Poultry)	Index of Marketing Costs	Adj. R <sup>2</sup>	<i>rho</i>
Broilers							(Turkey)			
Boneless breast	-0.10 (0.86)	-0.35** (0.10)	0.82** (0.04)	-1.95	0.17 (0.12)	0.24** (0.11)	-0.03 (0.05)	0.01 (0.20)	0.96	-0.31
Ribbed breast	-0.26 (0.91)	-0.37** (0.09)	0.80** (0.04)	-1.85	0.15 (0.13)	0.27** (0.12)	-0.06 (0.05)	0.05 (0.21)	0.95	-0.33
Drumsticks	2.29 (2.00)	0.07 (0.09)	0.74** (0.09)	0.27	0.22 (0.17)	-0.26 (0.18)	0.03 (0.05)	0.03 (0.05)	0.90	0.43
Leg quarters	3.542** (1.54)	-0.07 (0.09)	0.91** (0.07)	-0.78	-0.45** (0.22)	0.51** (0.19)	0.03 (0.06)	0.03 (0.06)	0.89	0.21
Wings	-1.09 (1.50)	-0.12 (0.08)	0.92** (0.06)	-1.50	0.32** (0.19)	-0.11 (0.17)	0.01 (0.07)	0.01 (0.07)	0.88	0.02
Turkeys							(Broiler)			
Tom	-2.04** (0.77)	-0.06 (0.04)	0.54** (0.06)	-0.13	0.31** (0.09)	-0.11 (0.09)	-0.19** (0.05)	0.42** (0.18)	0.87	0.16
Hen	-1.93** (0.96)	-0.07** (0.03)	0.28** (0.11)	-0.10	0.59** (0.12)	-0.26** (0.10)	-0.29** (0.07)	0.38 (0.22)	0.83	0.32
Drumsticks	0.29 (2.11)	-0.07 (0.11)	0.77** (0.06)	-0.30	0.31 (0.27)	-0.21 (0.26)	-0.11 (0.12)	-0.13 (0.49)	0.71	-0.13
Wings	-3.17** (1.60)	0.01 (0.11)	0.77** (0.06)	-0.04	0.39 (0.22)	0.66 (0.37)	0.08 (0.11)	0.66 (0.37)	0.71	-0.26
Breast	-0.85 (1.03)	-0.03 (0.06)	0.51** (0.14)	-0.06	0.47** (0.19)	-0.15 (0.14)	-0.41** (0.14)	0.25 (0.24)	0.80	0.07

Note: Standard error reported in parentheses. Two asterisk indicates values statistically different from zero at the 0.05 level.

these values were above 0.50, indicating that long-run shocks to independent variables will be more than twice the reported magnitude and as high as 12 times the reported magnitude.<sup>2</sup>

The two broiler short-run own-cut flexibilities that were statistically significant were negative and inflexible in prices (elastic in quantities). For the broiler cuts, statistically significant own-cut flexibilities were  $-0.35$  for boneless breast and  $-0.37$  for ribbed breast. Thus, a one-percent increase in per-capita broiler consumption would lead to a 0.35-percent and 0.37-percent decrease in wholesale prices of ribbed and boneless breast, respectively. The impact of a one-percent increase in per-capita turkey consumption had far less pronounced impacts on wholesale turkey cut prices, 0.08 percent decrease in the wholesale price of hens.

Capps *et al.* found that own-cut flexibilities for different beef primals were inflexible in prices and ranged from  $-0.03$  to  $-0.95$ . The long-run flexibilities for wholesale cuts of beef reported by Capps *et al.* ranged from  $-0.30$  to  $-2.18$ , indicating that some wholesale beef primal cuts are flexible (inelastic) in the long-run. In the current analysis, the long-run own-price flexibilities for broiler boneless and ribbed breasts and wings are flexible. However, the magnitude of most long-run own-cut flexibilities indicate that wholesale prices are not very responsive to changes in per-capita consumption. The small, in magnitude, own-price flexibilities may be due to the changes in consumer utility functions over the period of study.

Cross-product flexibilities for beef, pork, and poultry are reported in Columns 6 through 8. Poultry refers to per-capita consumption of turkey for the broiler meat wholesale price equations and per-capita consumption of broiler for the turkey meat wholesale price equations. Statistically significant cross-product flexibilities for poultry were negative as expected; however, there were only three. The three statistically significant flexibilities were

broiler for the turkey cut equations, indicating there is a price effect from an increase of per-capita consumption of broiler meat on turkey cut price. Broiler meat is apparently a substitute for turkey toms, hens, and breasts.

An increase in per-capita consumption of beef and pork generally had a positive impact on wholesale prices when the values were statistically different from zero. This result was not as expected. The long-term storage capabilities of broiler and turkey cuts at the retail level may have had an impact on this result. Capps *et al.* found a similar result for the effect of an increase in per-capita pork consumption on price of various wholesale beef cuts. Also, Capps *et al.* estimated an aggregate inverse demand equation for chicken and found the cross-product flexibility for beef was negative and the cross-product flexibility for pork was positive. For the current study using individual wholesale poultry cuts, beef and pork did not compete with broiler and turkey wholesale cuts as has been found for the case of retail demand for these products, e.g., Brester and Schroeder; Eales and Unnevehr; and Huang. Of course there is always the potential for poor data to yield results that do not conform to theory.

An increase in the marketing cost index had an economically significant (different from statistically significant) impact on wholesale prices only for turkey tom, hen, wings, and breast. The impacts were positive, as expected, and this indicates that an increase in marketing costs causes turkey cut prices to increase, but not broiler cut prices. For broilers this result is consistent with the results of Bernard and Willet. Bernard and Willet found transportation costs did not Granger Cause changes in the wholesale poultry prices.

Table 3 reports the percentage change in wholesale price relative to December for individual wholesale cuts of broilers and turkeys. Percentage changes were calculated at  $(e^{Bt} - 1) \times 100$ . A p-value of the test that seasonal intercept shifters are jointly different from zero is reported in Column 2. For all wholesale cut prices evaluated the null-hypothesis of the coefficients jointly equal to zero was rejected. Statistically significant, at

<sup>2</sup> The long-run impact multiplier is calculated as one over one minus the coefficient of the lagged dependent variable.

**Table 3.** Percentage Change in Monthly Price Relative to December (Dependent Variable is Wholesale Cut Price).

Wholesale Cut	p-value <sup>a</sup>	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.
<b>Broilers</b>												
Boneless breast	0.00	11.2**	9.7**	14.6**	14.5**	17.7**	12.3**	15.9**	11.7**	10.8**	-2.1	3.7
Ribbed breast	0.00	17.3**	19.5**	15.4**	18.4**	24.9**	16.1**	18.5**	15.9**	10.8**	5.4	8.18
Drumstick	0.04	-0.4	-1.2	-0.4	-2.9	-0.5	-1.1	-7.3	-6.8	0.6	0.1	-1.2
Leg quarters	0.04	5.7	5.1	-2.3	0.6	8.5	5.1	6.5	7.9	11.6**	5.0	-1.3
Wings	0.00	-10.6**	-22.8**	-14.4**	-16.0**	-10.6**	-3.4**	-13.1**	-17.4**	-15.2	-18.7**	-14.9**
<b>Turkeys</b>												
Toms	0.00	-3.9	3.4	9.2**	9.5**	10.3**	11.3**	10.8**	12.6**	10.5**	12.1**	13.6**
Hen	0.00	-11.9**	-7.4**	-1.0	-1.5	-3.7	-3.1	-2.4	-0.9	0.3	7.7**	11.9**
Drumsticks	0.00	-4.7	10.6	8.8	-10.8	-3.4	-7.4	-10.9	6.7	9.5	6.9	3.1
Wings	0.01	-4.0	13.8**	4.6	-0.9	-4.6	-4.1	-12.1**	-3.4	5.8	0.8	3.6
Breast	0.00	-1.5	5.7	9.2**	5.1	7.6**	4.7	5.9	5.4	8.6**	6.9**	6.8

Note: Two asterisks indicate coefficient estimate used to calculate percentage change statistically different from zero at the 0.05 level.

<sup>a</sup> P-value on F-statistic of seasonal intercept variables jointly statistically different from zero.

the 0.05 level, changes in wholesale price are denoted with a double asterisk. Wholesale cut prices of chicken and turkey exhibited seasonal trends in this data. For instance, the wholesale price of hen turkeys is the highest relative to December in October and November and the lowest during January and February. The relative pattern is similar for toms. This pattern corresponds to the purchasing pattern of turkey meat around the holiday season and the reduction in demand for turkey shortly after as persons fill up on turkey. Capps *et al.* also found seasonality to be a significant factor affecting wholesale beef primal prices. Schrimper, in evaluating seasonal poultry consumption patterns over time, found seasonal consumption patterns for both broiler and turkey meats. Schrimper reported the last three months of the year outpaced other months in total consumption.

## Conclusions

The focus of this study was on understanding factors affecting wholesale poultry prices. This information is needed so that poultry processors, retailers, and producers may better understand how consumer purchasing patterns affect price changes. This study revealed that consumer demand for poultry meats varies by cut and that there are some seasonal tendencies.

Monthly wholesale broiler prices evaluated in this study included boneless breast, ribbed breast, drumstick, leg quarters, and wings. Monthly wholesale turkey prices evaluated in this study included toms, hens, drumstick, wings, and breast. Results suggest that seasonal differences between these price cuts exist. Furthermore, own-cut and cross-cut flexibilities were unique to individual cuts. Changes in marketing costs had an economically significant effect on all but one of the turkey cut prices, but on none of the broiler cut prices.

By understanding the seasonal patterns in wholesale poultry cut prices as shown by this study, producers, retailers, and processors can better anticipate changes in the weighted average wholesale broiler or turkey price. Depending on the weight placed on the individ-



ual cut in the weighted wholesale price, different cut prices have different impacts on this weighted average price throughout the year. Further analysis is needed to determine the impact of changes in price of individual cuts on the weighted average wholesale price of either broilers or turkeys.

As the pork and beef industries evolve into a more vertically coordinated marketing system, the wholesale price will play an ever-increasing role in determining producer prices or contract grower payments. Capps *et al.* evaluated factors affecting wholesale beef cut prices. However, the rapid change in structure of the hog industry suggests a similar analysis for factors affecting wholesale pork prices is needed.

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