

## **How Has Economy-Wide Inflation Impacted Consumer Sensitivity to Pork Prices?**

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## **Executive Summary**

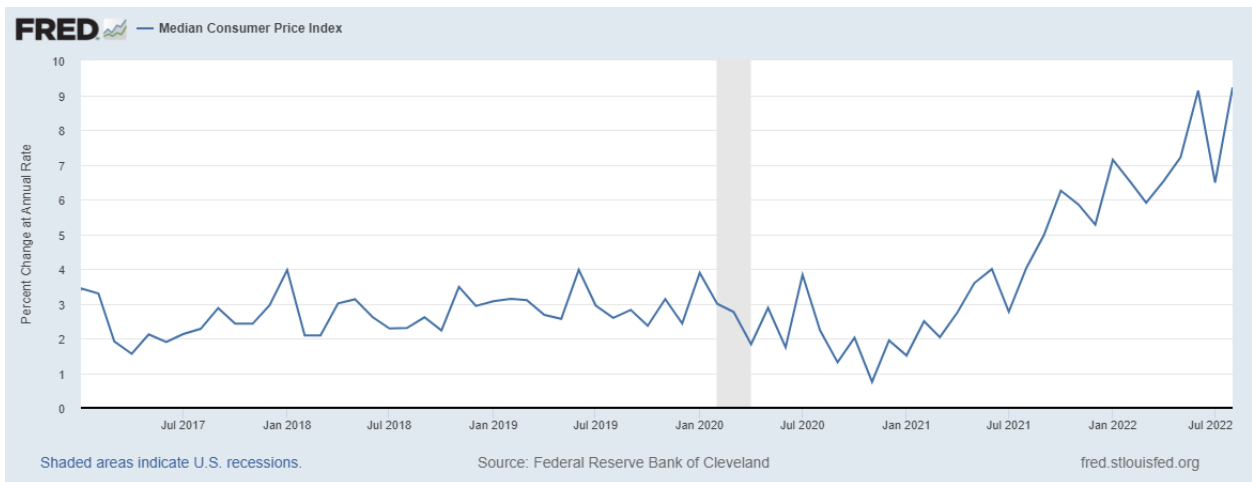
U.S. residents are experiencing inflation at levels not seen in over four decades. How consumers subsequently alter purchasing patterns is of elevated interest for many industries. This report assesses how consumer retail pork price sensitivity is impacted by inflation in the U.S.

- Bureau of Labor Statistics and Meat Demand Monitor data indicate realized impacts of elevated inflation include:
  - Real earnings have declined since the second quarter of 2020.
  - The typical worker in January 2020 would earn enough in one hour to buy 9.1 lbs of ham, 8.4 lbs of pork chop, or 5.1 lbs of bacon with these amounts declining to 7.7, 7.6, and 4.4 lbs, respectively by August 2022.
  - The relative importance of price in protein purchasing decisions increased between the second quarter of 2021 and the second quarter of 2022.
- Econometric analyses using weekly IRI retail market data spanning 51 U.S. markets in the January 2017 to August 2022 period broadly confirms consumers are becoming more sensitive to prices on retail pork products.
- The retail loin market stands out as an area likely driving broader pork category adjustment and increased price sensitivity. Conversely there is limited evidence of increasing price sensitivity in pork sausage and bacon markets.
- Implications of diverse price sensitivity include varied consumer response to marketing and promotion efforts.



## 1. Introduction and Background

The U.S. is in midst of ongoing, economy-wide inflation at levels not experienced in more than four decades. For a recent history, consider the January 2017 to August 2022 period.<sup>1</sup> As shown in figure 1, the median consumer price index (CPI) ranged from 1.50% to 4.00% in the three years preceding the pandemic (January 2017 – February 2020). Then, with noted variability, inflation generally declined from 3.0% in February 2020 to a low of 0.75% in November 2020. Since November 2020 annual inflation has increased persistently, staying above 4.0% since August 2021, with the most recent estimate being 9.23% in August 2022.



**Figure 1. Median Consumer Price Index, January 2017 – August 2022 (Source: Federal Reserve Bank of Cleveland, MEDCPIM158SFRBCLE)**

There are many underlying factors suspected to be contributing to elevated inflation, which in turn raises substantial interest in how consumers are responding to rapidly increasing prices. In a previous report, we explored the drivers of price increases in the pork sector. This project is, instead, focused on how consumer price sensitivity in

<sup>1</sup> Throughout this report we will use the Federal Reserve Bank's Median Consumer Price Index as our measure of inflation faced by consumers. This measure is updated monthly and available online in the FRED database here: <https://fred.stlouisfed.org/series/MEDCPIM158SFRBCLE#>

U.S. retail pork markets is being impacted by inflation. To appreciate this focus, note consumer purchasing power is impacted by multiple things beyond the cost of items available to them. Namely, wages and earnings of consumers (along with previously accrued savings and borrowing capacity) dictate the financial resources available for purchases. Accordingly, to further appreciate the impact of rising inflation one must assess patterns in wages and earnings. Furthermore, it is useful to consider patterns in real wages and earnings – that is, the net compensation residents receive once adjusting wages and earnings for inflation. Figure 2 provides a summary of one such measure as provided by the Bureau of Labor Statistics.<sup>2</sup>

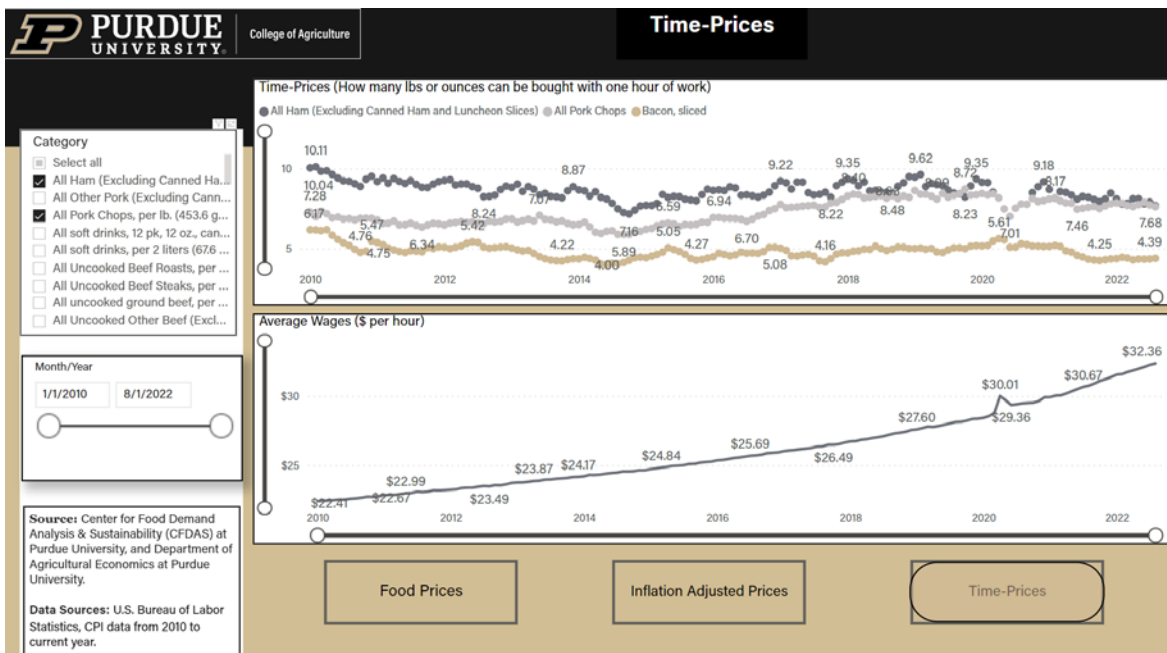


**Figure 2. Median Usual Weekly Real Earnings (Wages and Salary Workers, 16 Years and Over, Employed Full Time), January 2017 – August 2022 (Source: U.S. Bureau of Labor Statistics, LES1252881600Q)**

As shown in figure 2, real earnings growth was experienced for most of the pre-pandemic period. In fact, during the presented Q1.2017-Q2.2022 period, real earnings peaked in Q2.2020 with persistent decay thereafter through Q2.2022. At the time of this writing in September 2022 it further is important to note that the magnitude of decline in Q3.2022 is yet to be fully experienced yet is likely to build upon this trend.

<sup>2</sup> This measure is updated monthly and available online in the FRED database here: <https://fred.stlouisfed.org/series/LES1252881600Q#>

Figure 3 compares prices and wages specifically for pork products using Bureau of Labor Statistics data compiled in the data dashboard created the Center for Food Demand Analysis and Sustainability at Purdue University.<sup>3</sup> In particular, the dashboard shows how many pounds of pork can be bought with an hour's worth of work given the average wage rate at a particular time. The data show a reduction in consumer's buying power for ham and bacon. In January 2010, the typical worker would earn enough to buy 9.1 lbs of ham, 8.4 lbs of pork chop, or 5.1 lbs of bacon. However, by August 2022 an hour's worth of work would only enable the typical worker to buy 7.7 lbs of ham 7.6 lbs of pork chops, or 4.4 lbs of bacon.



**Figure 3. Price of Pork Products Relative to Average Wages**

Complimentary insights on the situation faced by U.S. residents are provided by the Meat Demand Monitor (MDM) project which is supported in-part by the pork checkoff. Here we leverage the recently launched MDM dashboard created by Justin Bina to

<sup>3</sup> This dashboard and associated reports are available online: <https://ag.purdue.edu/cfdas/>.

succinctly compare key measures in Q2.2022 and Q2.2021.<sup>4</sup> While reported household incomes rose 0.3% in this period, spending on food for at home consumption rose by 6.4% and for food away from home rose by 1.4%. Consistent with points above, this likely leads to elevated importance of price to consumers. In fact, MDM information confirms price is growing in importance when making protein purchasing decision. Specifically, each MDM survey participant is presented a list of 12 factors and asked to indicate the four that are most, and four that are least, important in their protein purchasing decisions. Nationally, the share indicating price was among their top four considerations increased from 46.3% in Q2.2021 to 48.2% in Q2.2022.<sup>5</sup> Figures 4 and 5 from the MDM dashboard augment these national statistics to provide visuals of how this pattern varies across U.S. states, in Q2.2021 and Q2.2022 respectively. While price ranks highly as a top consideration for residents in all states, these state-level figures indicate the relative importance of price is lower in coastal states (VA and CT have lowest scores in Q2.2022) and higher in several central states (CO and NE have highest scores in Q2.2022).

While one may be tempted to think this would correspond with interest in changing diet away from regularly consuming meat. On the contrary, the share of residents self-declaring a diet comprised of regularly consuming animal products increased from 67.7% in Q2.2021 to 70.1% in Q2.2022. This reaffirms sustained interest in meat consumption. Those interested in additional details on self-declared diet patterns are encouraged to see the recent article we published in *Meat Science*.<sup>6</sup>

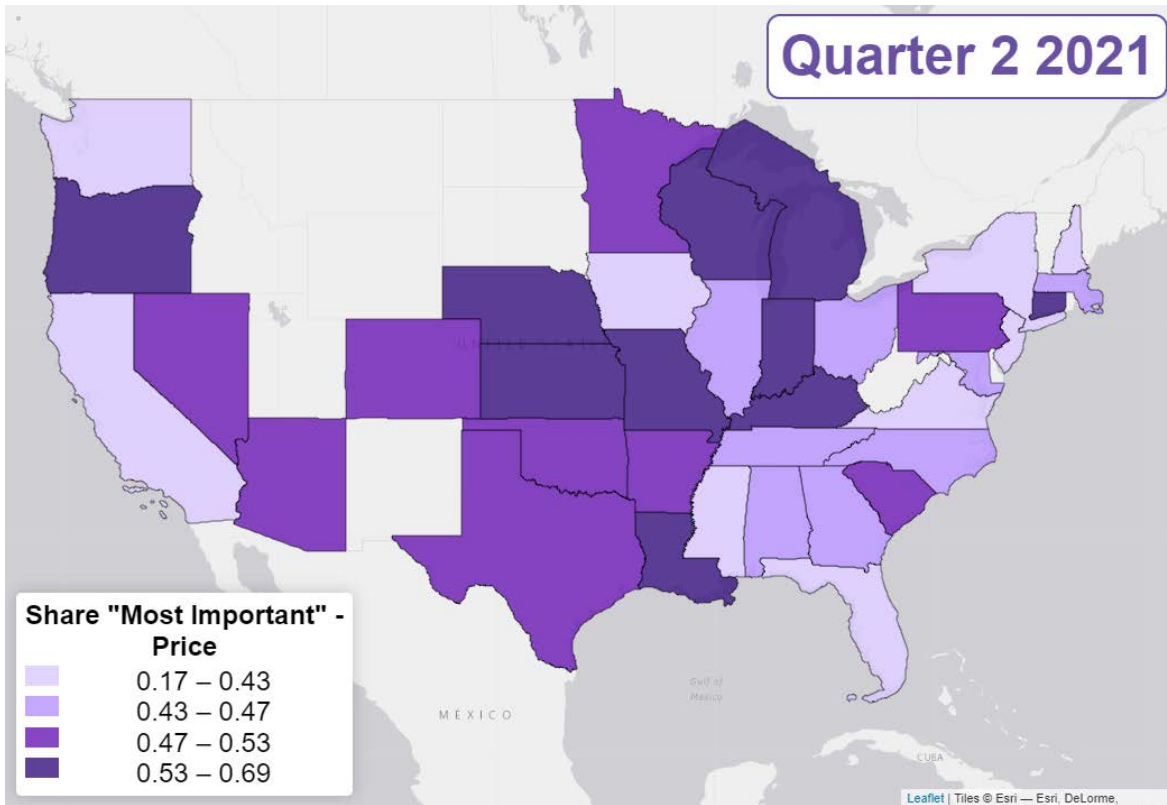
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<sup>4</sup> A link to the MDM dashboard, as well as underlying data, base reports, etc., is available online:

<https://www.agmanager.info/livestock-meat/meat-demand/monthly-meat-demand-monitor-survey-data>.

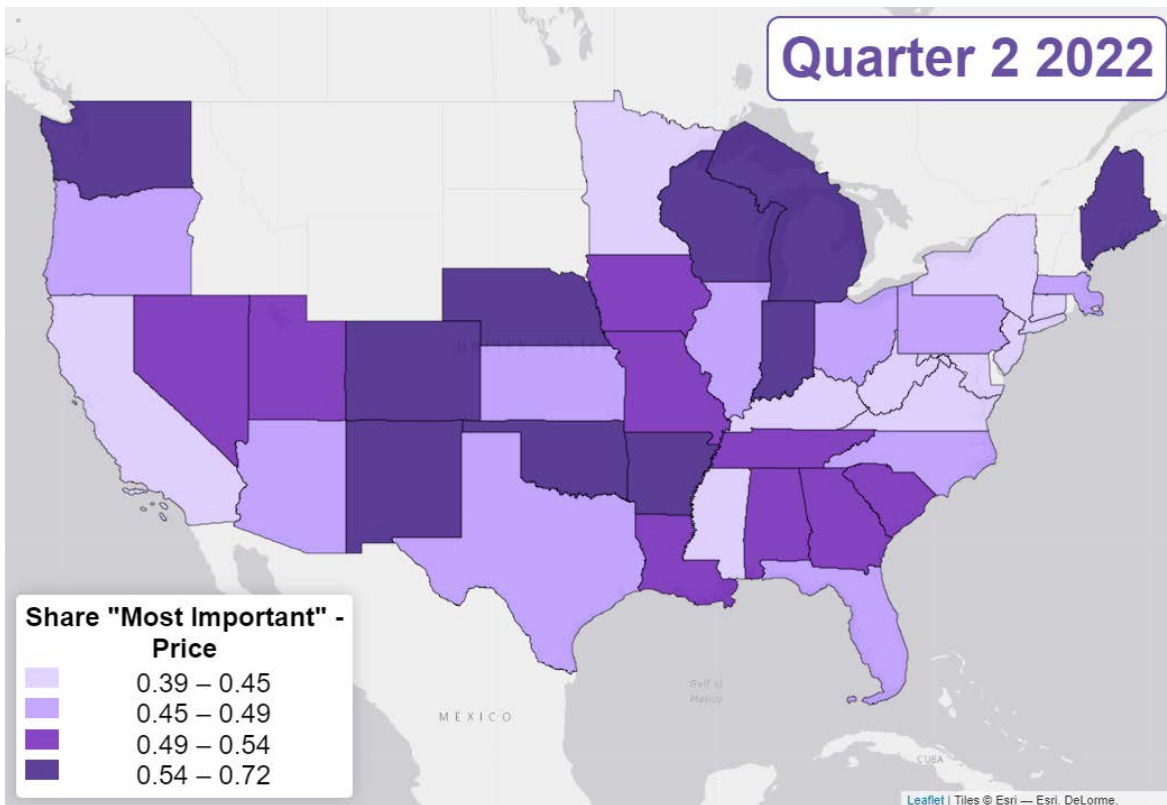
<sup>5</sup> Similarly, the share indicating price was a bottom four consideration fell from 21.5% in Q2.2021 to 20.8% in Q2.2022. Note each month base MDM reports present corresponding “Protein Values” scores and regularly indicate taste, freshness, safety, and price are top considerations for consumers in their protein purchasing decisions.

<sup>6</sup> This August 2022 *Meat Science* article titled “U.S. Perspective: Meat Demand Outdoes Meat Avoidance” is available online: <https://www.sciencedirect.com/science/article/pii/S0309174022001115>.



**Figure 4. Share Indicating Price is Top Protein Purchasing Factor, Q2.2021 (Source: Meat Demand Monitor Dashboard)**





**Figure 5. Share Indicating Price is Top Protein Purchasing Factor, Q2.2022 (Source: Meat Demand Monitor Dashboard)**

To succinctly summarize the situation implied by the above discussion and figures, U.S. residents increasingly face a net economic decline as their earnings are not keeping up with the costs of items available for them to purchase. The result is that consumers will “tighten their financial belts,” increase a focus on asking prices, and alter spending, savings, and/or borrowing decisions to reflect financial realities in their household. The exact adjustments are bound to vary notably over households and likely differ across a host of product categories in the U.S. economy. This project focuses on possible adjustments in retail U.S. demand for pork. More narrowly, the primary objective of this report is to assess how consumer retail pork price sensitivity is impacted by inflation in the U.S.

## 2. Methods

We first highlight a recent report that utilized similar data and methods. In March 2021, Drs. Tonsor and Lusk delivered a report titled “Consumer Sensitivity to Pork Prices: A Comparison of 51 U.S. Retail Markets and 6 Pork Products.”<sup>7</sup> The 2021 report reflected a deep analysis of IRI retail data on volume and expenditure spanning January 2016-December 2020 for 6 different pork products (loin, ribs, shoulder, breakfast sausage, dinner sausage, bacon) in 51 separate U.S. retail markets. The main purpose of the 2021 report was to provide elasticity estimates for each pork product in each retail market, statistics which reveal how sensitive consumer purchases are to price changes. A central finding was consumer sensitivity to prices indeed varies notably over pork products and geographically distinct markets. This finding of elasticities differing over pork products, coupled with the above noted dynamics in inflation and real-purchasing power of U.S. residents, motivates this current project interest in quantifying how price sensitivity has changed for consumers buying different pork products (loin, bacon, etc.) in retail markets.

The current report focuses on inflationary impacts. Accordingly, our focus is primarily on temporal changes, or adjustments over time.<sup>8</sup> To meet this project’s objective, we estimate a series of consumer demand models. Specifically, consumer demand models are used to identify how consumer sensitivity to retail pork prices has differed during recent periods of economy-wide inflation. We use available IRI retail market data for the January 2017 to August 2022 period. Across all products and retail markets (same as those in the noted 2021 report) there is a total of 14,208 weekly observations used in our analysis.

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<sup>7</sup> The full report is available here: <https://www.agmanager.info/livestock-meat/meat-demand/meat-demand-research-studies/consumer-sensitivity-pork-prices-comparison>. Given differences in time period, associated market coverage procedures, and methods applied across projects care should be taken in comparing elasticity estimates across the 2021 report and this current report.

<sup>8</sup> As a related point of clarification, while one can define all combinations of pork products (e.g. loin vs. bacon), geographically-defined markets (e.g. Phoenix vs Chicago), and temporal periods (e.g. CPI below 2.5% vs over 4.0% or 2022 vs an earlier calendar year) there is not sufficient resulting observations for each combination to confidently estimate models for these narrowly defined combinations.

We specify retail pork demand models where the quantity purchased is a function of own-price, prices of beef and chicken (to control for cross-protein price effects), population (to control for market size effects), and monthly seasonality factors. This model is:

$$1) \ln Q_{imt} = \alpha_i + \beta_{i,Own} \ln P_{imt} + \beta_{i,Beef} \ln P_{Beef,mt} + \beta_{i,Chicken} \ln P_{Chicken,mt} + \eta_i Population_m + \sum_{l=1}^{11} \mu_{il} Month_l + e_{imt}$$

where  $\ln$  is natural log operator,  $Q_{imt}$  is the quantity of good  $i$  (loin, ribs, etc.) purchased in market  $m$  (Chicago, Phoenix, etc.) in week  $t$ ,  $P_{zt}$  is the price of good  $z$  in market  $m$  in week  $t$ ,  $Population_m$  is the population in market  $m$ ,  $Month_l$  is a dummy variable equal to 1 for month  $l$  and 0 otherwise,  $e_{imt}$  is the model's error term, and remaining terms are parameters to be estimated. Our primary interest is in the  $\beta_{i,Own}$  parameter which is an own-price elasticity of demand estimate.

We implement the model presented in equation (1) as a random coefficients model. Narrowly PROC MIXED in SAS is used to estimate mixed models where population and seasonality are specified as fixed effects that do not vary over time periods of interest while the intercept, own-price elasticity, and two cross-price elasticity parameters are specified as random effects. This approach ultimately provides elasticity estimates specific to each "regime" or "time period of interest" based on how the random effects are specified.

Here these regimes or time periods of interest are first defined by economy-wide inflation as shown in figure 1. Narrowly, four CPI levels within the January 2017-August 2022 period are identified: below 2.5% CPI (36.8% of observations), 2.5% to 3.0% CPI (22.3% of observations), 3.0% to 4.0% CPI (21.6% of observation), and over 4.0% CPI (19.3% of observations). These four CPI "regimes" are reasonably balanced in relative frequency during the examined period and are intuitive leading to easier interpretation of results.

While most of the over 4.0% CPI observations occur in 2021-2022 it is important to note that some did occur in earlier years as shown in figure 1. Likewise, there are cases of the CPI being below 2.5% both in 2017 and 2020. That is, there is not a clean and simple alignment of calendar years with the four identified CPI regimes employed here. Accordingly, as an additional assessment, we alternatively define regimes of interest based on calendar years. That is, instead of assigning market observations to period delineated by CPI we consider six alternative regimes reflecting the five completely observed years of 2017-2021 as well as the partially complete year of 2022. This additional assessment is included both to provide a clean assessment of recent period pork demand elasticities and to reflect the fact consumers are facing an array of changes beyond economy-wide inflation. That is dynamics such as work-from-home patterns and other adjustments besides general economic inflation may well alter consumer pork price sensitivity.

In our random coefficients models this approach results in “regime-specific” elasticity estimates. That is, our approach produces pork price sensitivity parameters for each of the four identified CPI regimes or calendar years as presented in the results section.

### 3. Results

The model reflected by equation (1) is presented generically to apply for all estimated models. Here we estimate models separately for six pork product-categories (loin, ribs, shoulder, breakfast sausage, dinner sausage, and bacon) as well as pork in aggregate. This approach results in elasticity estimates being derived for separate pork product-categories and time periods yielding insights to how consumer sensitivity to retail pork prices is adjusting.

Table 1 presents own-price elasticity of demand estimates specific to four different CPI regimes. Examining the aggregate pork estimates first we see consumers are much more price sensitive when the CPI exceeds 4.0%. Leveraging the product-category level estimates reveals that pork loin is a sizeable portion of this adjustment. That is, consumer sensitivity to retail loin prices is much higher when the CPI exceeds 4.0%. Price sensitivity appears to also be higher for shoulder and breakfast sausage when the CPI exceeds 4.0%. Conversely, elevated inflation does not appear to correspond with increased price sensitivity in pork ribs, dinner sausage, and bacon markets.

**Table 1. Own-Price Elasticity Estimates, Across CPI-Delineated Regimes (Mixed Model Approach)**

CPI Regime	Loin	Ribs	Shoulder	Breakfast Sausage	Dinner Sausage	Bacon	Pork (Aggregate)
CPI Regime 1 (Under 2.5%)	-0.488	-1.286	-1.746	-3.972	-1.122	-1.773	-0.676
CPI Regime 2 (2.5%-3.0%)	-0.547	-1.399	-1.680	-4.141	-1.218	-1.798	-0.830
CPI Regime 3 (3.0%-4.0%)	-0.466	-1.596	-1.646	-4.068	-1.256	-1.783	-0.677
CPI Regime 4 (Over 4.0%)	-1.003	-1.467	-1.961	-4.299	-1.088	-1.789	-1.246

Note: Breakfast sausage models were estimated with two random effects as the two cross-price effects were specified as fixed effects.

Table 2 is similarly designed to provide own-price elasticity of demand estimates separately by calendar year. Here across each examined pork product-category, as well as

pork in aggregate, estimates for 2022 (January-August) each indicate increased consumer sensitivity to retail prices relative to 2021. If one compares 2022 with earlier years, loin again stands out as being the area perhaps driving increased price sensitivity reflected in the aggregate retail pork category.

**Table 2. Own-Price Elasticity Estimates, Across Calendar Years (Mixed Model Approach)**

Year	Loin	Ribs	Shoulder	Breakfast Sausage	Dinner Sausage	Bacon	Pork (Aggregate)
2017	-0.713	-1.932	-1.700	-4.387	-1.497	-1.604	-0.781
2018	-0.491	-1.706	-1.747	-4.081	-1.403	-2.235	-0.721
2019	-0.512	-1.917	-1.673	-3.914	-1.498	-2.256	-0.923
2020	-0.411	-1.556	-1.633	-3.841	-1.283	-2.069	-0.735
2021	-0.728	-1.273	-1.801	-4.020	-0.934	-1.384	-0.999
2022 (January-August)	-1.037	-1.805	-1.830	-4.222	-1.605	-1.931	-1.182

As noted above, the 2021 report found significant heterogeneity in price-sensitivity across not only pork products (e.g. loin vs bacon) but also across retail markets (e.g. Phoenix vs. Chicago). Accordingly, it is useful to add a cross-check to our mixed model based findings that reflects likely variation across markets.

Table 3 presents a summary of own-price elasticity estimates that are derived from two-stage least squares models similar to what was employed in the 2021 report. These models are estimated separately by retail market for each of the four CPI regimes. However, compared to the 2021 report, each of these estimated models use a much smaller time-span of data consistent with our temporal interest in the impacts of inflation. In particular, for each retail market there are 109, 66, 64, and 57 weekly observations used in models specified for CPI regimes 1-4, respectively. Accordingly, as an upfront point of clarity, table 3 is included as a robustness check on the findings from table 1 with specific

values not being precise.<sup>9</sup> Given fragility of resulting estimates we focus on the median estimate over markets across the four CPI regimes.

**Table 3. Median Estimate of Own-Price Elasticity, Across CPI-Delineated Regimes (Two-Stage Least Squares by Market-Regime Combination)**

CPI Regime	Loin	Ribs	Shoulder	Breakfast Sausage	Dinner Sausage	Bacon	Pork (Aggregate)
CPI Regime 1 (Under 2.5%)	-0.425	-0.085	-1.641	-1.063	-0.652	-0.883	-0.108
CPI Regime 2 (2.5%-3.0%)	-0.500	0.630	-1.626	-1.682	-1.456	-1.395	0.082
CPI Regime 3 (3.0%-4.0%)	-0.725	-0.054	-1.563	-1.927	-2.148	-0.412	-0.025
CPI Regime 4 (Over 4.0%)	-1.442	-1.257	-2.041	-0.644	-1.462	-2.442	-1.274

Table 3 broadly reaffirms the above-finding of consumer price-sensitivity being higher during periods of elevated inflation. Specifically, the median (across retail markets) estimates indicate higher price-sensitivity when the CPI is above 4.0% for pork in aggregate as well as for loin, ribs, shoulder, and bacon. The breakfast and dinner sausage markets do not reveal this same pattern.

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<sup>9</sup> Two instances in table 3 of own-price elasticity values being positive underlie this word of caution. This likely reflects the limited sample size employed and corresponds with our main reliance on mixed models that are not focused on cross-market variation but rather temporal variation of central interest. We do not extend or cross-check to calendar year distinctions as corresponding data sub-samples would be even smaller.

#### **4. Conclusion**

As the U.S. continues to experience economy-wide inflation at levels not experienced by many residents a host of economic questions arise including exactly how households are adapting. This report uses January 2017 – August 2022 retail market data to examine how consumer sensitivity to retail pork prices may be evolving. A bottom-line summary statement is that consumer pork price sensitivity indeed varies over pork product-categories and appears to be changing over time. Increased sensitivity to retail pork prices is found to more clearly exist in the pork loin market.

These findings have implications beyond base understanding of consumer retail pork demand. Those marketing and promoting pork may alter featuring and related plans given refined insights into how consumer demand is evolving with changes in economy-wide inflation. For instance, finding consumers in the pork loin market are more price-responsive when inflation is elevated and during 2022 may indicate increased purchasing response to buy-one-get-one or other types of possible promotions. Conversely, the pork sausage and bacon markets do not show clear evidence of consumer price-sensitivity changing and hence previously experienced effectiveness of marketing and promotion efforts may remain a reasonable guide.