



United States Department of Agriculture

# WHAT ARE THE COMPONENTS OF FOOD PRICES? HOW IS FOOD INFLATION FORECASTED?

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The Findings and Conclusions in This Preliminary Presentation Have Not Been Formally Disseminated by the U. S. Department of Agriculture and Should Not Be Construed to Represent Any Agency Determination or Policy



# AGENDA

- Food price inflation
- Determinants of food prices
- U.S. retail food price forecasts

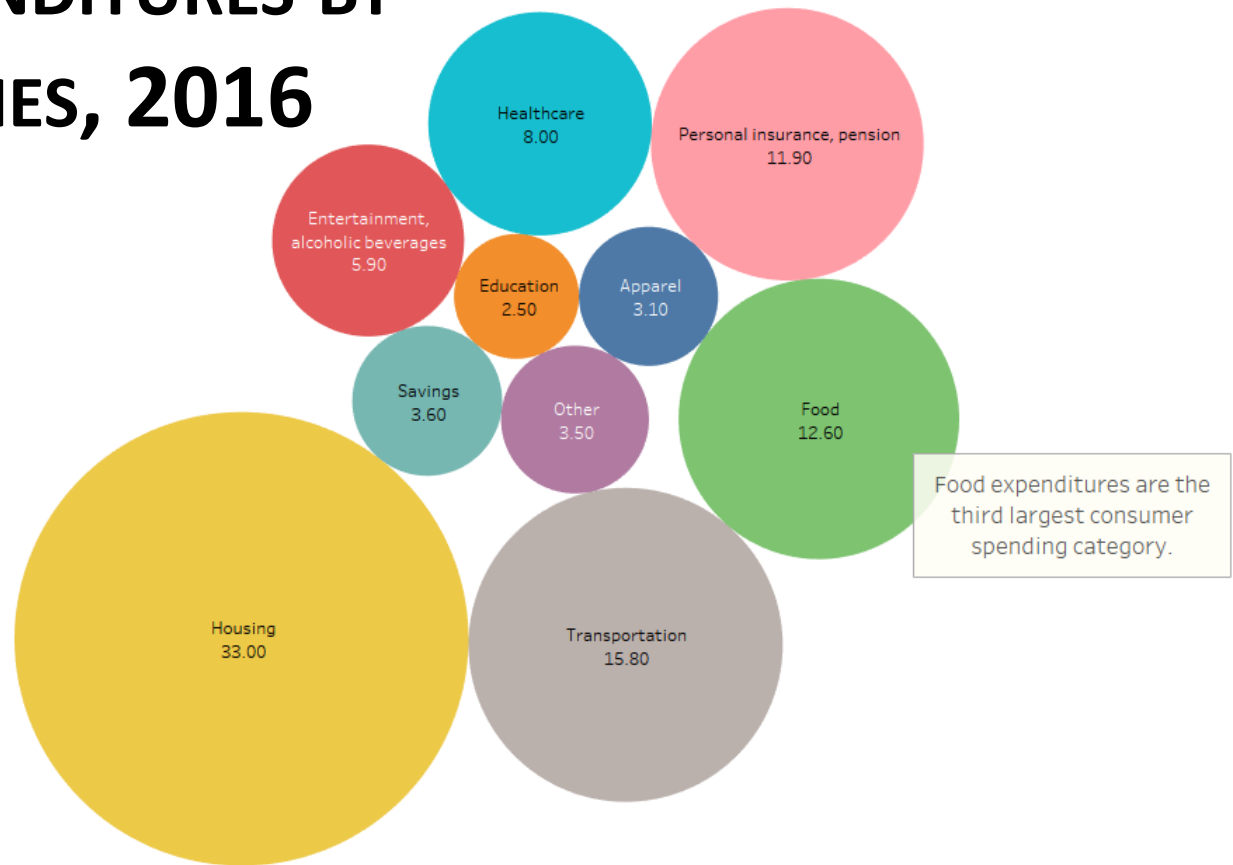


# WHY STUDY FOOD PRICE INFLATION?

- Food price inflation can affect the average consumer's household budget.
- Current food price conditions and inflation forecasts provide useful insights to farmers, food processors, wholesalers, as well as retailers



# SHARE OF U.S. HOUSEHOLD CONSUMER EXPENDITURES BY MAJOR CATEGORIES, 2016

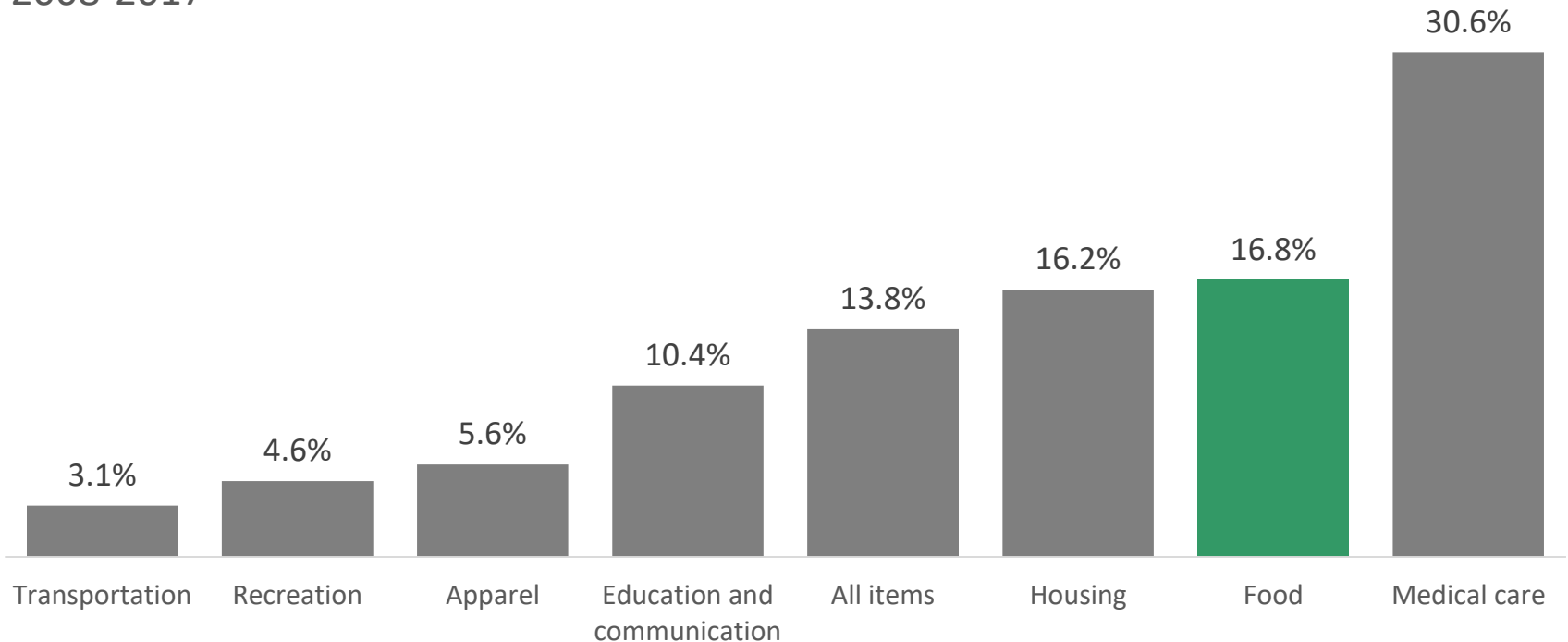


Note: "Other" includes personal care products, tobacco, and miscellaneous expenditures.  
Source: USDA, Economic Research Service using data from the U.S. Bureau of Labor Statistics.



# How U.S. Food Price Inflation Compares To Other Spending Categories

10-year Percent Change in Major U.S. Consumer Price Index Categories, 2008-2017



Source: USDA, Economic Research Service using data from the U.S. Bureau of Labor Statistics.



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# HOW DOES THE U.S. MEASURE FOOD PRICE INFLATION?

- The U.S. Bureau of Labor Statistics calculates the Consumer Price Index or CPI.
- The CPI is calculated using Laspeyres Index
  - Step 1: A base year is selected
  - Step 2: A basket of goods are selected
  - Step 3: Prices are collected for the same basket of goods

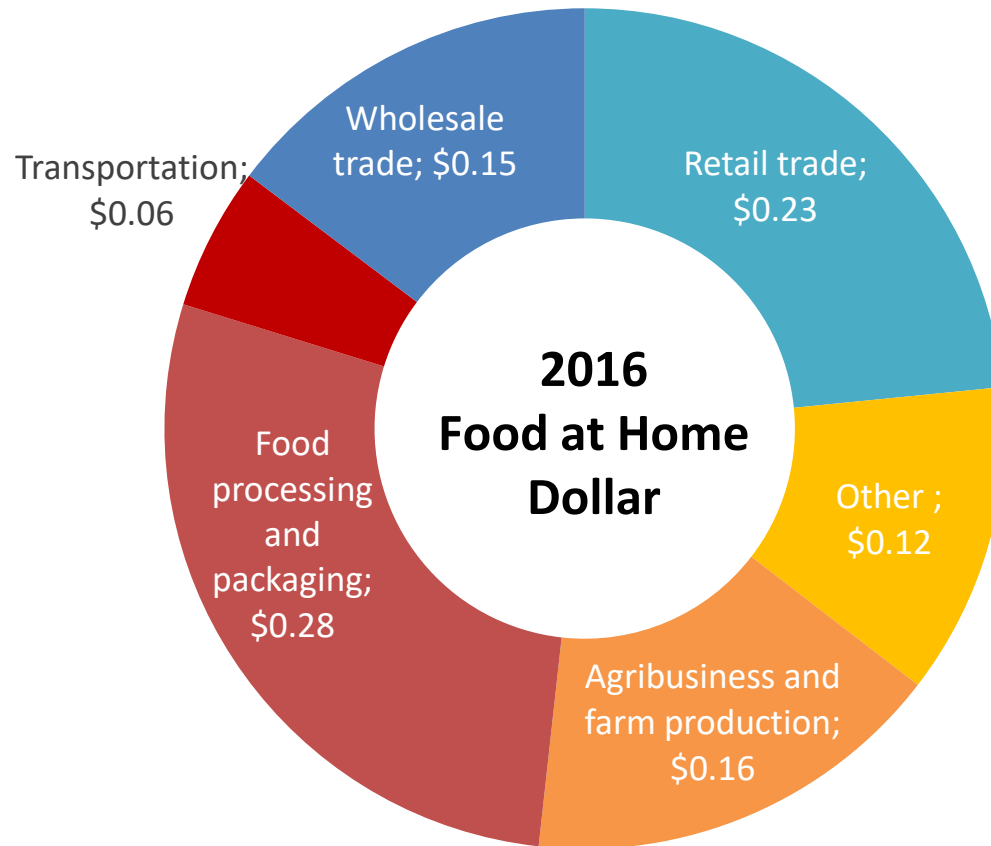




# WHAT ARE THE DETERMINANTS OF FOOD PRICES?



# THE INDUSTRY GROUP VALUE-ADDED SHARES OF THE U.S. FOOD DOLLAR

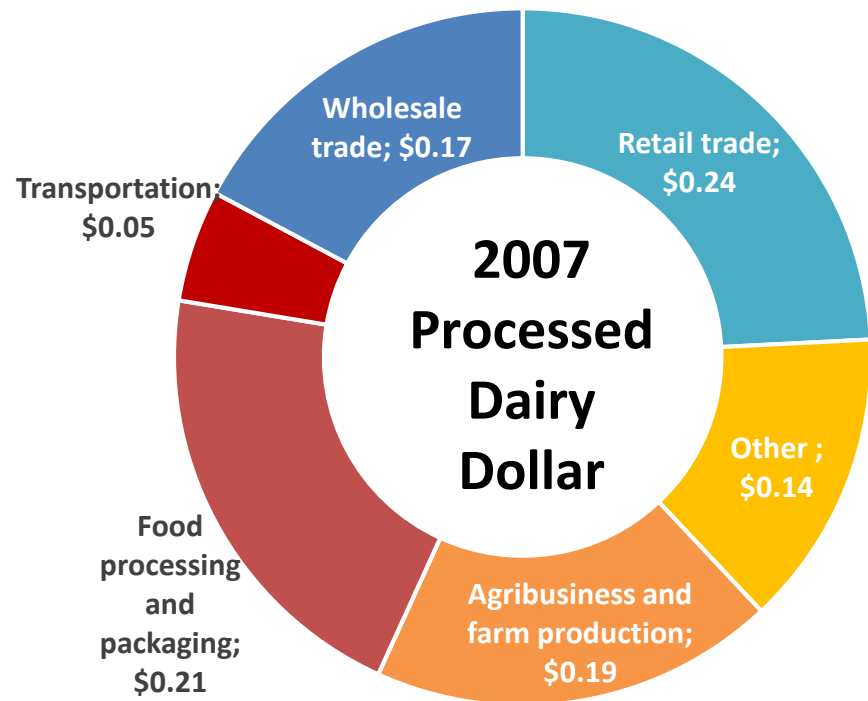
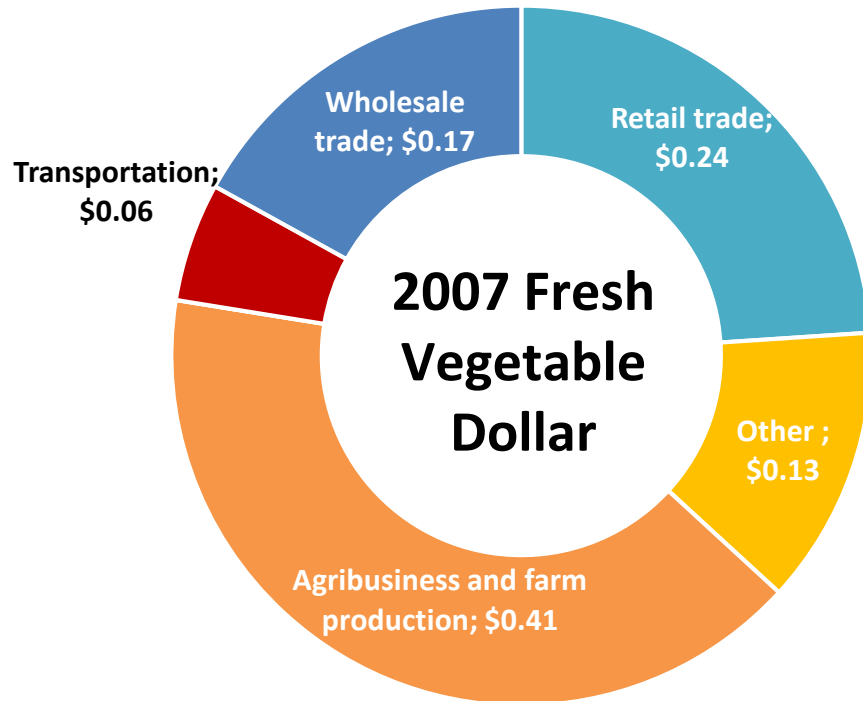


Note: Other includes: foodservices, advertising, legal and accounting, finance and insurance, and energy





# U.S. FOOD DOLLAR VARIES BY CATEGORY



# HOW IS THE U.S. FOOD DOLLAR CALCULATED?

- Uses data from two main sources:
  - U.S. Bureau of Labor Statistics' bi-annual input-output data.
  - Input-output data published by the U.S. Bureau of Economic Analysis.
- Calculates how a dollar of expenditures flows through to the value added by each factor.

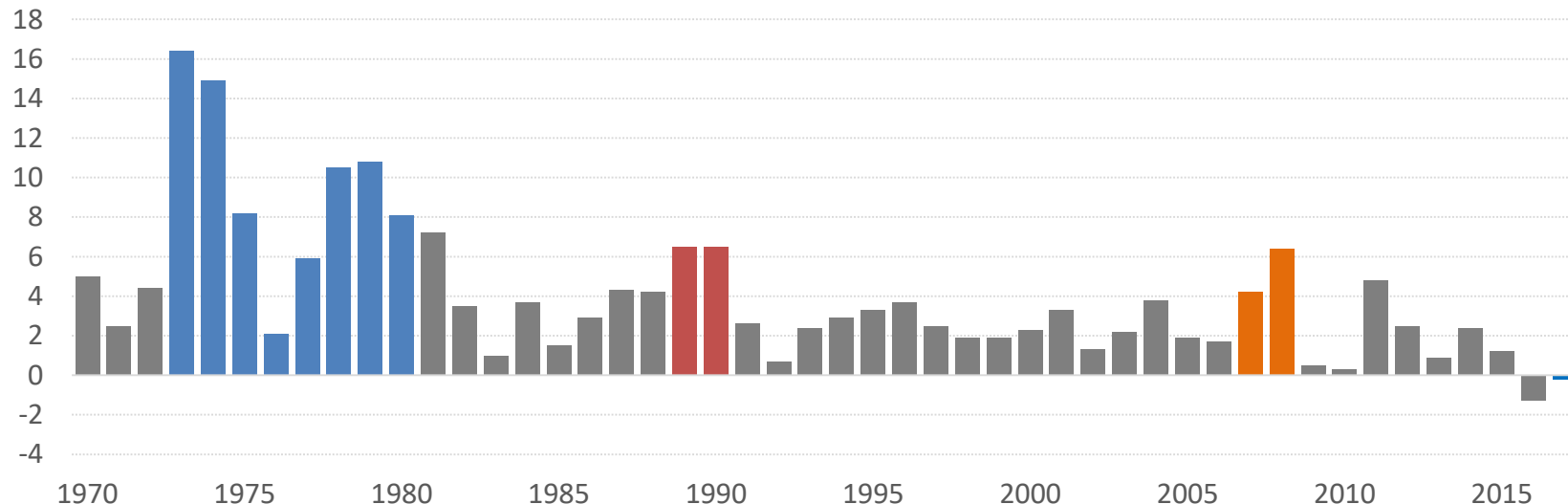


# RETAIL FOOD PRICE COMPONENTS HAVE IMPACTED FOOD PRICE INFLATION IN THE U.S.

- OPEC Oil Crisis: 1970s
- U.S. Drought: Late 1980s
- Spike in world grain, rice, and oilseed prices: 2007/2008

Consumer Price Index for Food At Home, 1970 - 2017

Percent change,  
annual



Source: USDA, Economic Research Service using data from the U.S. Bureau of Labor Statistics.



# OTHER FACTORS THAT AFFECT FOOD PRICES

- Consumer demand
- Supply disruptions
- Changes in purchasing power

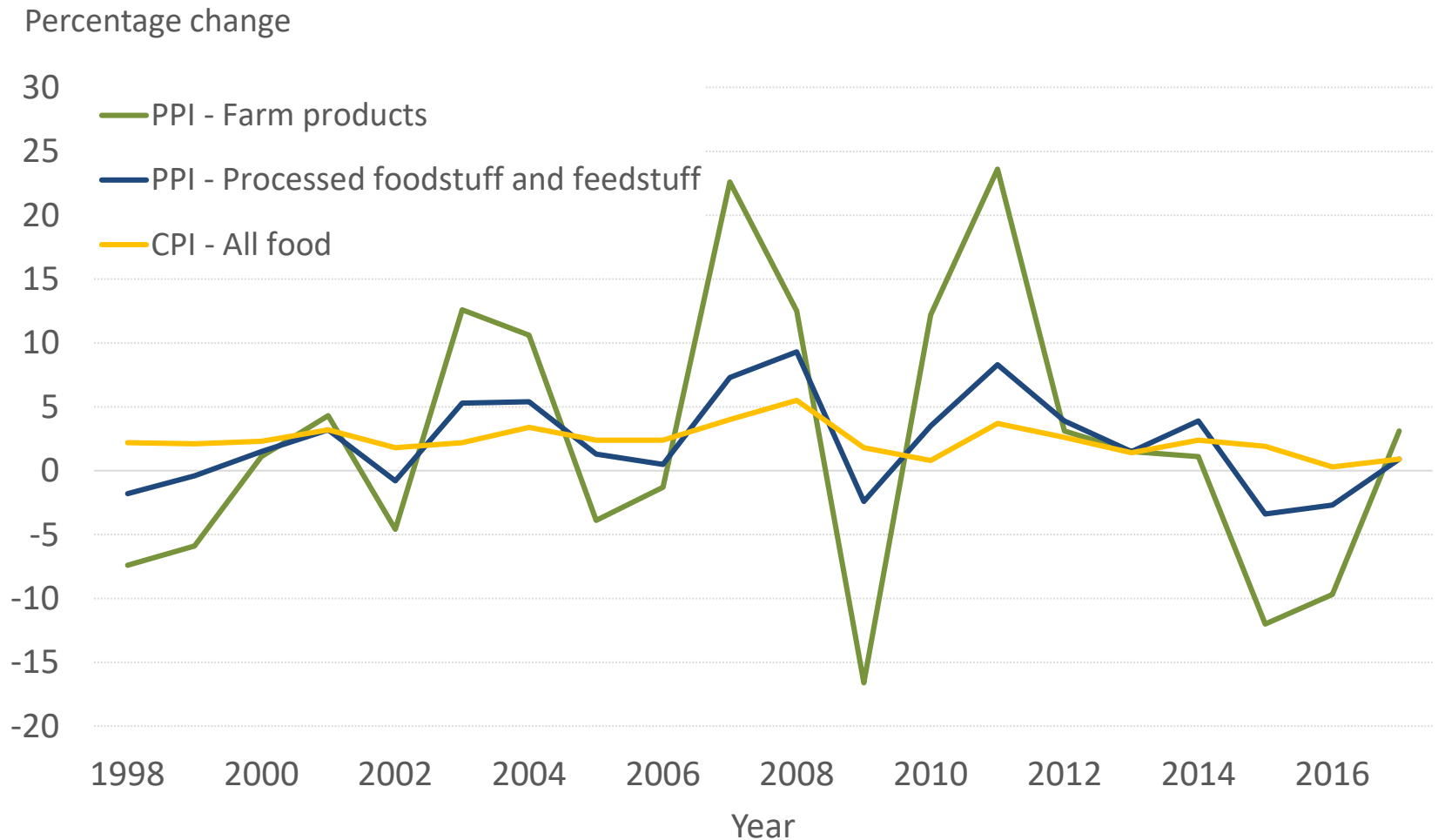


# HOW DO PRICE CHANGES AT EARLIER STAGES OF PRODUCTION PASS-THROUGH TO RETAIL?





# ANNUAL PERCENT CHANGE IN PRICE, BY STAGE OF PRODUCTION



Source: USDA, Economic Research Service using Bureau of Labor Statistics data.



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# WHAT CAN WE DO TO MEASURE PASS-THROUGH?

- Select data that are representative of the food supply chain.
- Use a autoregressive analysis that accounts for various factors affecting retail food prices as well as lag terms.
- The results aid in the development and analysis of the forecast models by measuring rate and timing of pass-through.

Source: Leibtag, E. "How Much and How Quick? Pass Through of Commodity and Input Cost Changes to Retail Food Prices," American Journal of Agricultural Economics 91: 1462-67, 2009.



# PASS-THROUGH TIMES AND RATES

Retail Category	Time to Pass Through (Months)	Rate of Pass Through (Percent)
Beef	1 to 2	6 to 18
Pork	1 to 3	2 to 4
Poultry	1 to 2	6 to 8
Eggs	3 to 5	5 to 8
Milk	1 to 5	5 to 18
Bread	1 to 6	2 to 6
Oranges	1 to 2	11
Lettuce	1 to 2	16

Source: Leibtag, E. "How Much and How Quick? Pass Through of Commodity and Input Cost Changes to Retail Food Prices," American Journal of Agricultural Economics 91: 1462-67, 2009.



# HOW DO WE FORECAST FOOD PRICE INFLATION?



# ABOUT OUR FORECASTS



- Food Price Outlook data product
- 12 – 18 month forecast horizon (new year is added in July)
- Forecast 7 farm, 6 wholesale, and 19 retail food categories

Available at:

<http://www.ers.usda.gov/data-products/food-price-outlook.aspx>





# FORECASTING METHOD BY CATEGORY

## Autoregressive moving average approach

- Food away from home
- Other meats
- Fish and seafood
- Processed fruits and vegetables
- Sugar and sweets
- Nonalcoholic beverages

## Vertical price transmission ECM approach

- Beef and veal
- Pork
- Poultry
- Dairy products
- Fats and oils
- Cereals and bakery products

## Vertical price transmission ARDL approach

- Eggs
- Fresh fruits
- Fresh vegetables

## Weighted Average

- All food
- Food at home
- Meats, poultry, and fish
- Meats
- Fruits and vegetables
- Fresh fruits and vegetables



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# AUTOREGRESSIVE MOVING AVERAGE APPROACH

- Used for categories subject to data limitations
  - Only considers information about series being forecast
  - No corresponding PPIs are calculated for these categories
- Relies on lagged and current values of the CPI being forecasted
- $\Delta CPI_{i,t} = \sum_{i=1}^p \alpha_{i,i} \Delta CPI_{i,t-i} + \sum_{j=1}^q \beta_j e_{i,t-j} + \varepsilon_{i,t}$ 
  - Where: i = CPI category being forecast; t = time period



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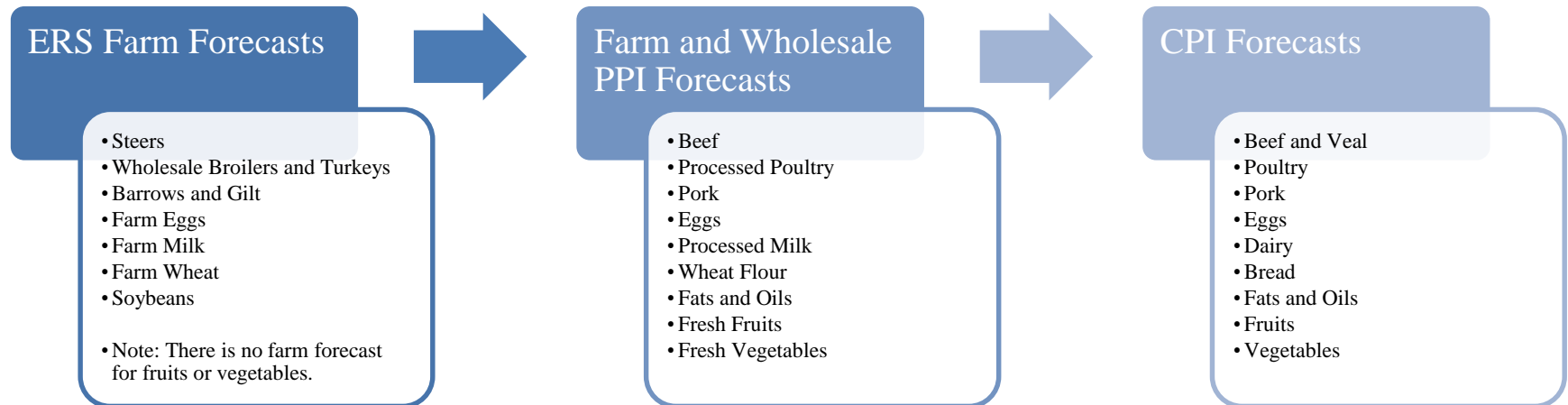
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# VERTICAL PRICE TRANSMISSION APPROACH

- Incorporates input prices at each stage of production





# UNIFYING FRAMEWORK

- Two time-series models are considered. Model selection depend on whether co-integration is found between the price changes in different stages of production.
  - If found: two step error correction model (ECM)
  - Otherwise: auto-regressive distributed lag (ARDL) model



# AUTOREGRESSIVE DISTRIBUTIVE LAG EXAMPLE

- $\widehat{\Delta CPI}_{i,t} = \alpha + \sum_f \beta_f \Delta Farm Forecast_{i,t-f} + \sum_j \beta_j \Delta CPI_{i,t-j} + \beta_d \Delta diesel_t + \beta_e \Delta electricity_t + \beta'_s sbreaks_i + \varepsilon_{i,t}$
- Where:
  - $i$  = Wholesale PPI series to be forecast
  - $t$  = time period
  - PPI = Wholesale producer price index
  - Farm forecast = internal ERS forecast of farm level price
  - Diesel = value of diesel PPI
  - Electricity = value of electricity PPI
  - Sbreaks = a vector of binary variables for any structural breaks

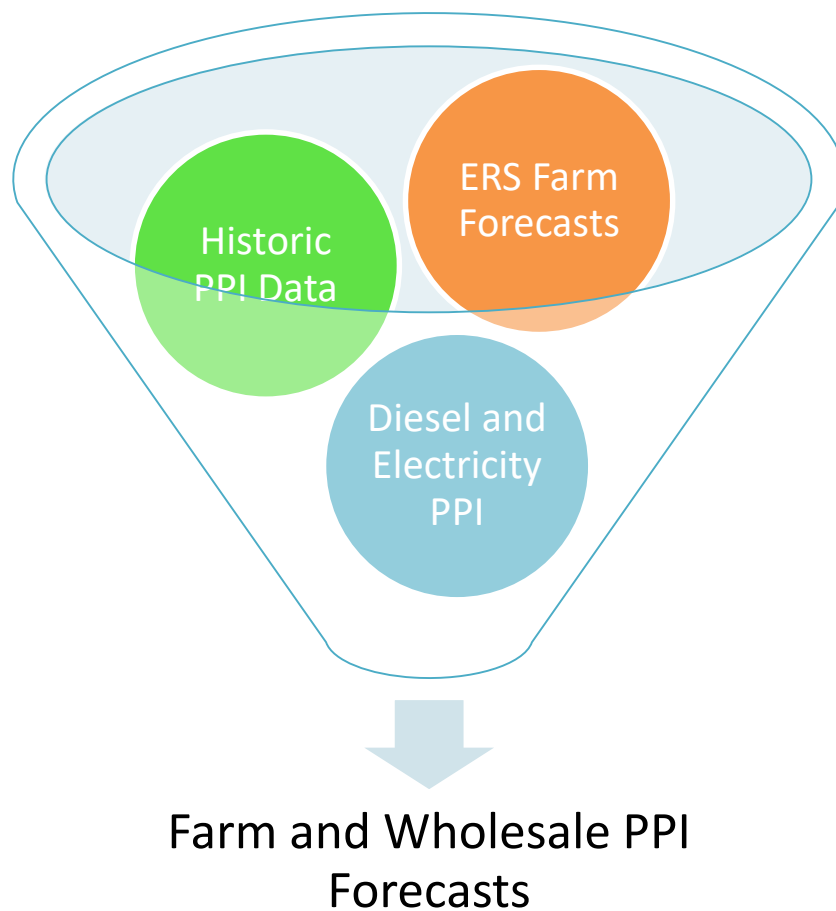


# ERROR CORRECTION MODEL EXAMPLE

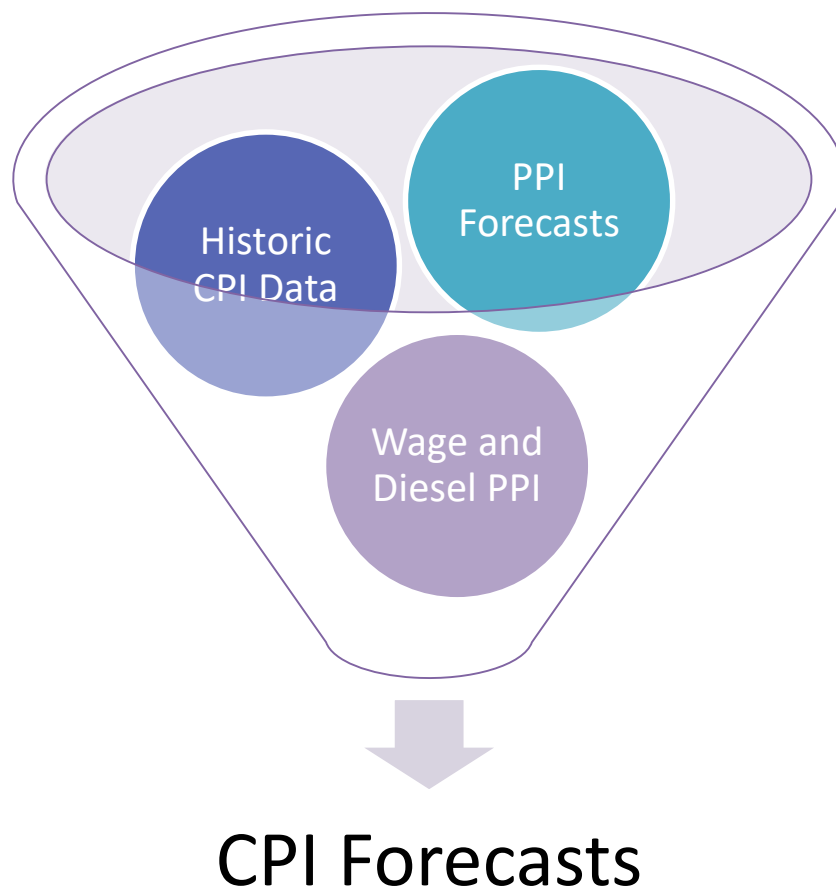
- $$\widehat{\Delta CPI}_{i,t} = \alpha + \sum_j \beta_j \Delta PPI_{i,t-j} + \sum_k \beta_k \Delta CPI_{i,t-k} + \beta_d \Delta diesel_t + \beta_g \Delta gsw_t + \beta'_s sbreaks_i + \gamma Z_{t-1} + \varepsilon_{i,t}$$
- Where:
  - $i$  = series to be forecast
  - $t$  = time period
  - CPI = retail food consumer price index
  - PPI = wholesale producer price index
  - Diesel = value of diesel PPI
  - gsw = grocery store wage
  - Sbreaks = a vector of binary variables for any structural breaks
  - $Z$  = “error correction” term



# FIRST STAGE



# SECOND STAGE





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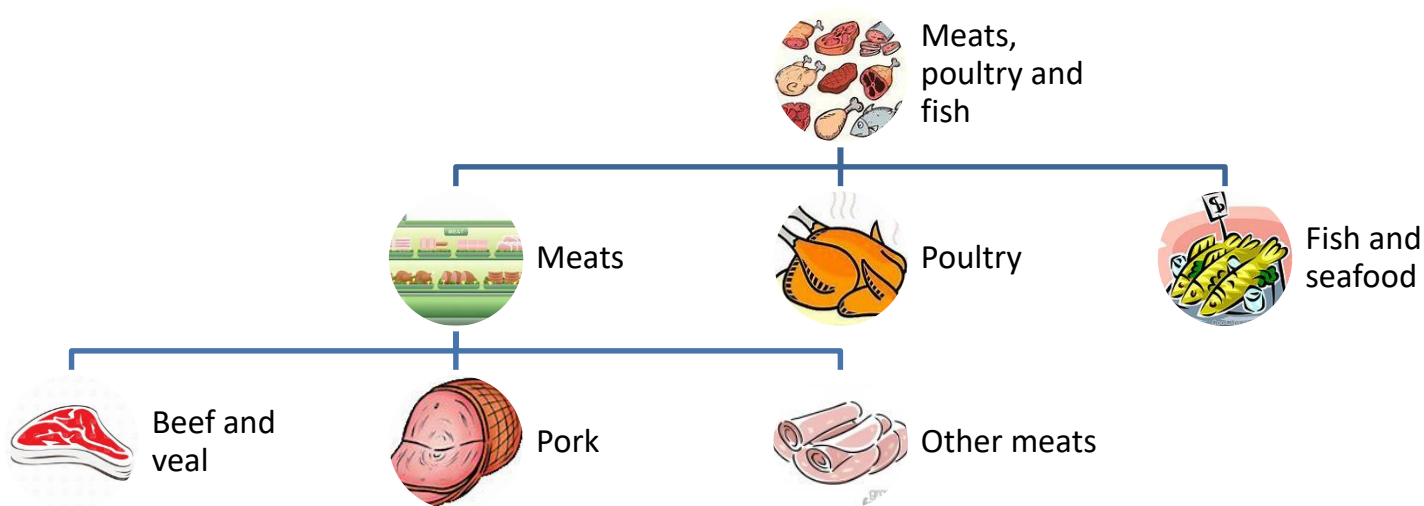
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# WEIGHTED AVERAGE APPROACH

- Applied to forecasts for broader groups



- Weights are drawn from BLS Consumer Price Index relative importance shares



# POST ESTIMATION EVALUATION FINDINGS

- Precision of forecasts somewhat improved under new methodology
  - Fewer forecast revisions
  - Smaller absolute adjustments



# ONGOING RESEARCH

- Incorporate forecast averaging and hierarchical forecasting techniques
- Use of simulation to improve confidence interval estimation for year-over-year inflation forecasts
- Expand number of categories being forecast



# PUBLICATION ON FOOD PRICE FORECASTING METHODOLOGY

Provides a detailed outline of U.S. forecasting methodology, along with measures to test the precision of the estimates.



# THANK YOU!

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# ACCURACY METRICS

- Mean squared error, mean squared percentage error
- Theil's U
- Directional analysis

