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Using Rolling-Window Multilateral Price Indexes to Track Food Costs across Space and over Time

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2024 ASSA Annual Meeting, San Antonio, TX
Recent Research on Price Index Topics
Marriott Rivercenter
Sunday, January 7, 2024: 8:00 AM – 10:00 AM (CST)

The findings and conclusions in this presentation are those of the author(s) and should not be construed to represent any official USDA or U.S. Government determination or policy.

This presentation was supported in part by the U.S. Department of Agriculture, Economic Research Service.

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ERS calculates new panel food price indexes called Food-at-Home Monthly Area Prices (F-MAP).

- Monthly price measures covering 2012–2020
  - Based on Circana InfoScan retail scanner data
  - Unit prices standardized to dollars/100-gram basis (mean and SE)
  - 6 price indexes: Laspeyres; Paasche; Törnqvist; Fisher Ideal; Gini-Elteto and Koves-Szulc (GEKS); Caves, Christensen and Diewert (CCD)
- 90 ERS Food Purchase Groups (EFPGs): classifies foods based on ingredients, nutrition, and convenience level
- National and for 14 geographic areas: 4 Census Regions and 10 major metropolitan areas

EFPGs classify foods based on ingredients (tier 1), nutrition (tier 2), and convenience level (tier 3).

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The Consumer Price Index (CPI) and F-MAP differ in scope and methods.

CPI	F-MAP
Comparisons over time	Comparisons over time/across areas
100 food categories nationally, 6 sub-nationally	90 food categories (EFPGs) nationally and sub-nationally
Outlets selected through stratified probability surveys	Opt-in census of retailers
Representative sample of products	All products at participating retailers
Modified geometric mean and Laspeyres index	4 bilateral and 2 multilateral price indices
Average unit prices for a selection of specific products	Average unit prices for EFPGs, which include all products sold at retailers

Multilateral price indexes are more appropriate for temporal and spatial price comparison than bilateral indexes.

A price index is transitive if the price ratio between entities i and j is the same whether i and j are compared directly or indirectly through a third entity k.

- Transitivity is especially important for spatial price comparison.
- The bilateral Laspeyres, Paasche, Fisher Ideal, and Törnqvist are not transitive.
- One solution is to create a $M \times M$ matrix of bilateral index numbers.
- A better solution is to create a $M \times 1$ column of index numbers using a multilateral index.
- The **GEKS is a multilateral price index** such that

$$P_{GEKS}^{0j} = \prod_{l=0}^{M} \left(P_F^{0l} \times P_F^{lj} \right)^{1/(M+1)}$$

There are some notable properties of multilateral price indexes.

- Replacing the Fisher Ideal index in GEKS with the Törnqvist index produces the multilateral CCD index
- Choice of base entity irrelevant (either an artificial base representing national average prices and sales or any market-period)
- Fully transitive
- Violates characteristicity (e.g., I want to compare Atlanta with Boston. Why should prices in New York City matter?)

Rolling windows mitigate the need for constant revision of published index numbers.

Fixed-basket indexes become less representative over time. Chaining by a moving base is prone to a downward chain drift. Multilateral indexes avoid chain drift but require revision of published index numbers when new data arrive. We can solve both issues by opening a rolling window (RW) to multilateral indexes.

The RWGEKS index for entity k in month $T+1$ (T = end of the base period) is

$$P_{RWGEKS}^{0k} = P_{GEKS}^{0j} \prod_{l \in I_{T+1:T-11}} \left(P_F^{jl} \times P_F^{lk}\right)^{1/M_{T+1:T-11}}$$

P_{GEKS}^{0j} is link entity j in T; $I_{T+1:T-11}$ is the set of all entities between $T-11$ and $T+1$ (window = one year); and $M_{T+1:T-11}$ is the number of entities in the set $I_{T+1:T-11}$.

RW GEKS and CCD have additional properties of note.

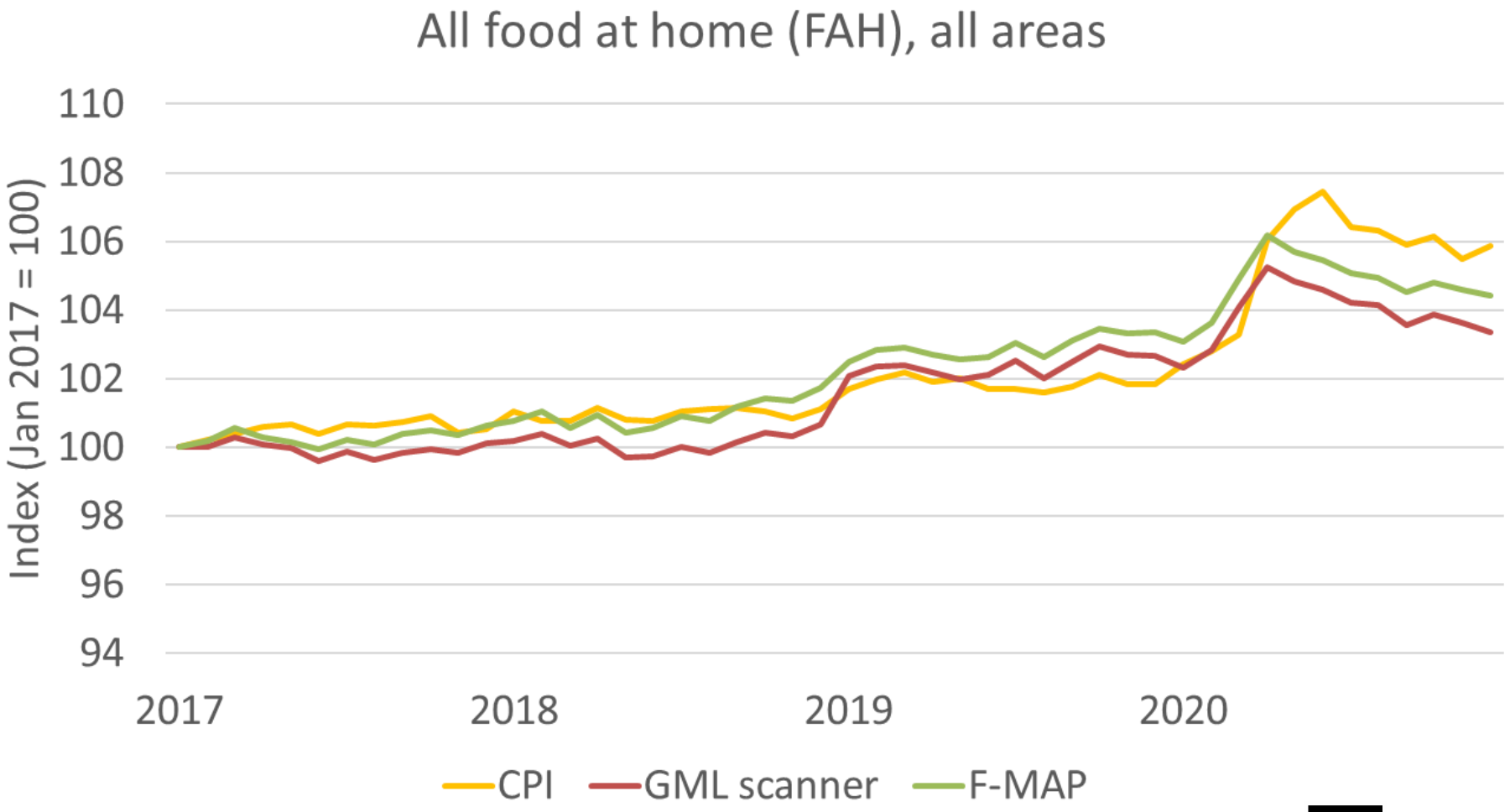
- Replacing P_{GEKS}^{0j} with P_{CCD}^{0j} and P_F with P_T gives the RWCCD index.
- Numerically identical to GEKS and CCD for entities in the base period.
- Can be free of chain drift (window length ≥ 1 year to be sure).
- Not fully transitive for all entities.
- Transitive between entities of the same period if they share the same link entity j.

To compare the F-MAP to CPI, an intermediate price index is constructed.

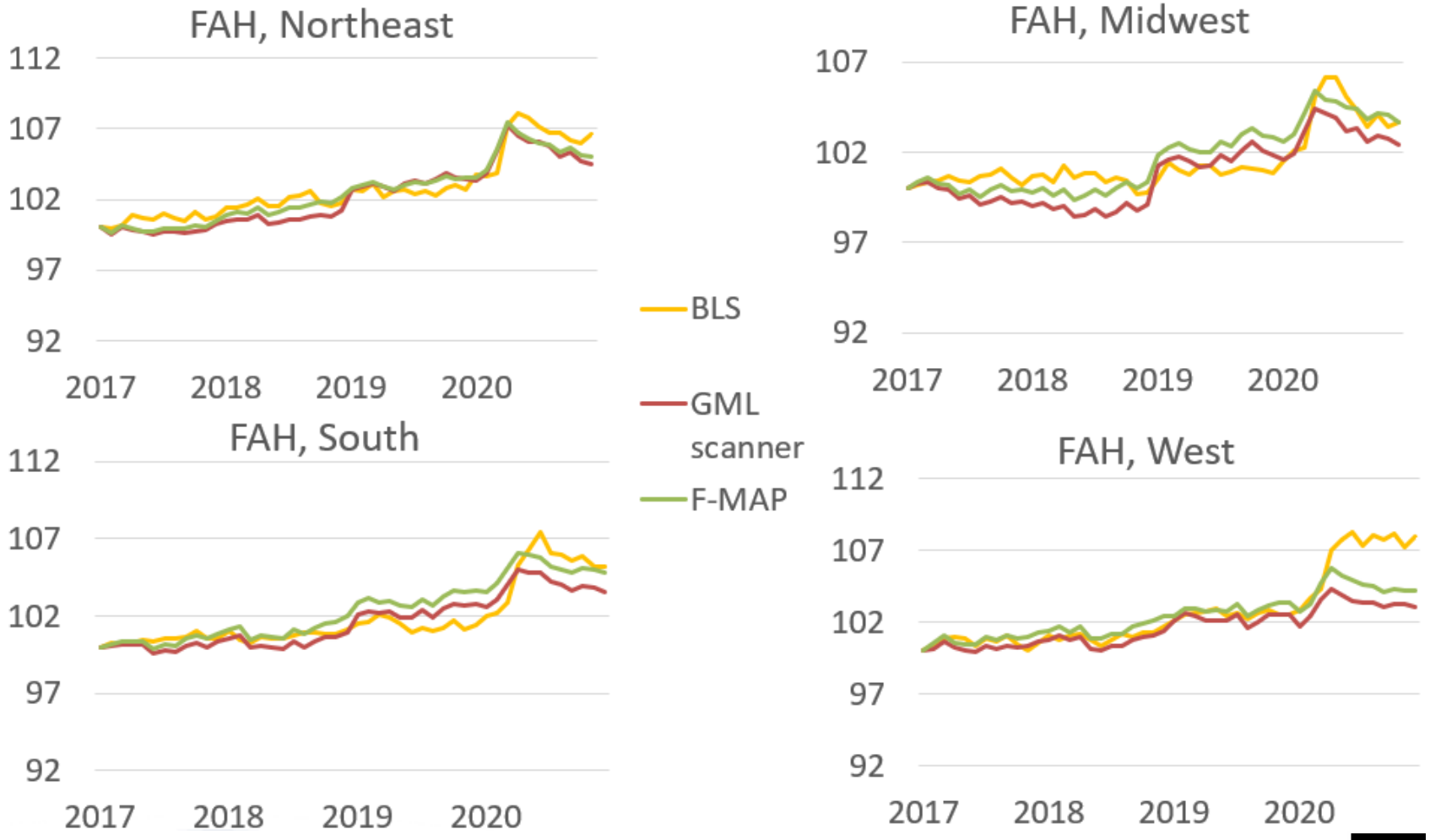
- Data sources and index construction both contribute to differences between F-MAP Laspeyres and CPI
- Construct indexes using scanner data similar to how BLS constructs CPI
  - Geometric mean index formula used to aggregate UPC-level prices in scanner data into EFPGs
  - Laspeyres index formula used to aggregate geometric mean price indexes for EFPGs into food groups that closely align with CPI food groups:

    all food at home (FAH) ● cereals and bakery products ● meats ● dairy products ● fruits and vegetables ● beverages
  - Infoscan weights or projection factors are used in construction of price indexes
- Intermediate price index called **Geometric Mean-Laspeyres (GML) scanner price indexes**.
- Difference between CPI and GML price indexes are due to differences in data

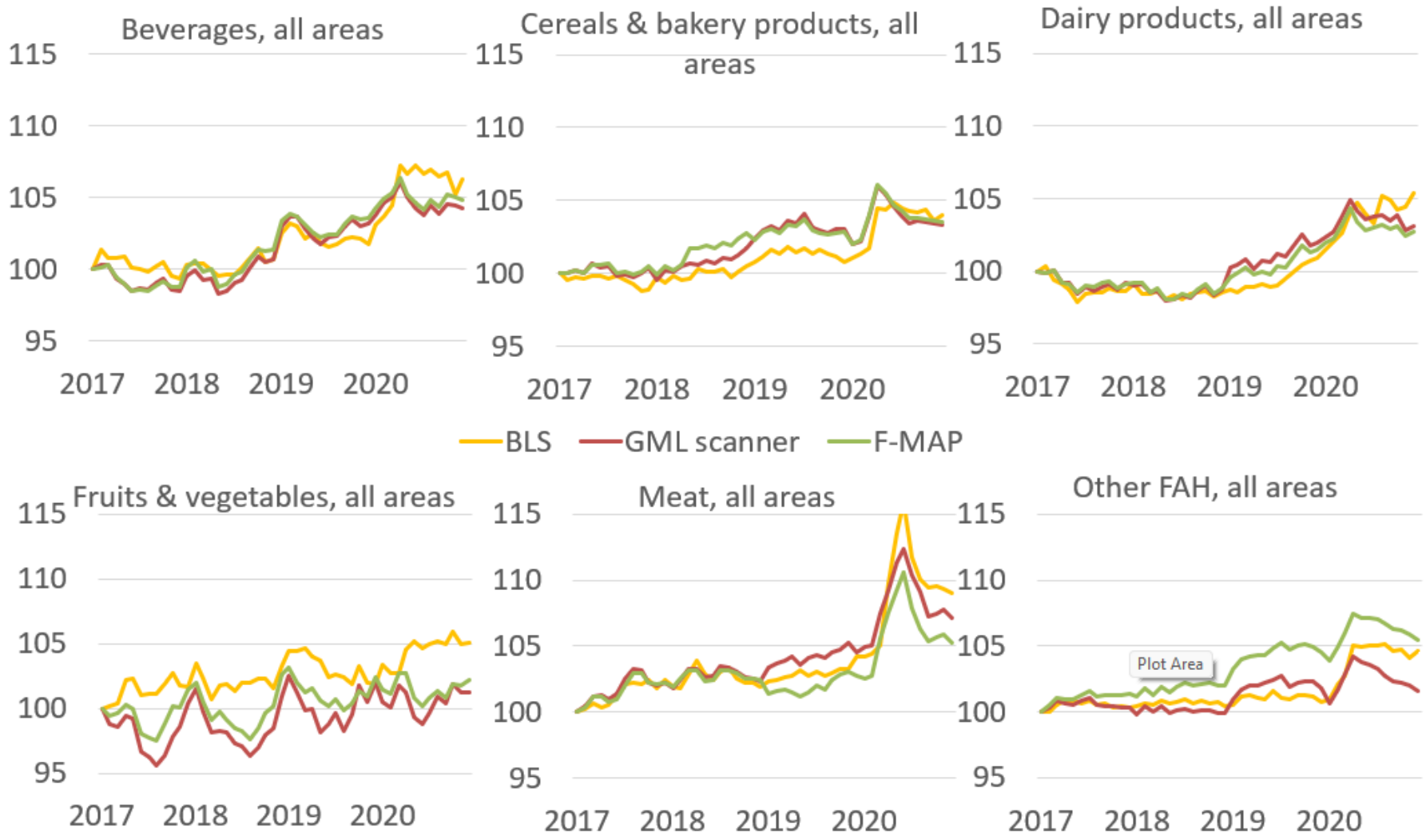
The CPI and F-MAP generally track each other but with some important differences.



These data- and all-other-factor-driven differences vary across regions…



…as well as products.



We isolate the contributions of data and formula effects using a two-stage regression.

Two-stage regression

- ❑ Stage 1: OLS regression of F-MAP Laspeyres (P^{FMAP}) on CPI (P^{CPI})

$$P^{FMAP} = \alpha + \beta P^{CPI} + u^1$$

- ❑ Stage 2: Regress residuals (u^1) on GML scanner index (P^{GML})

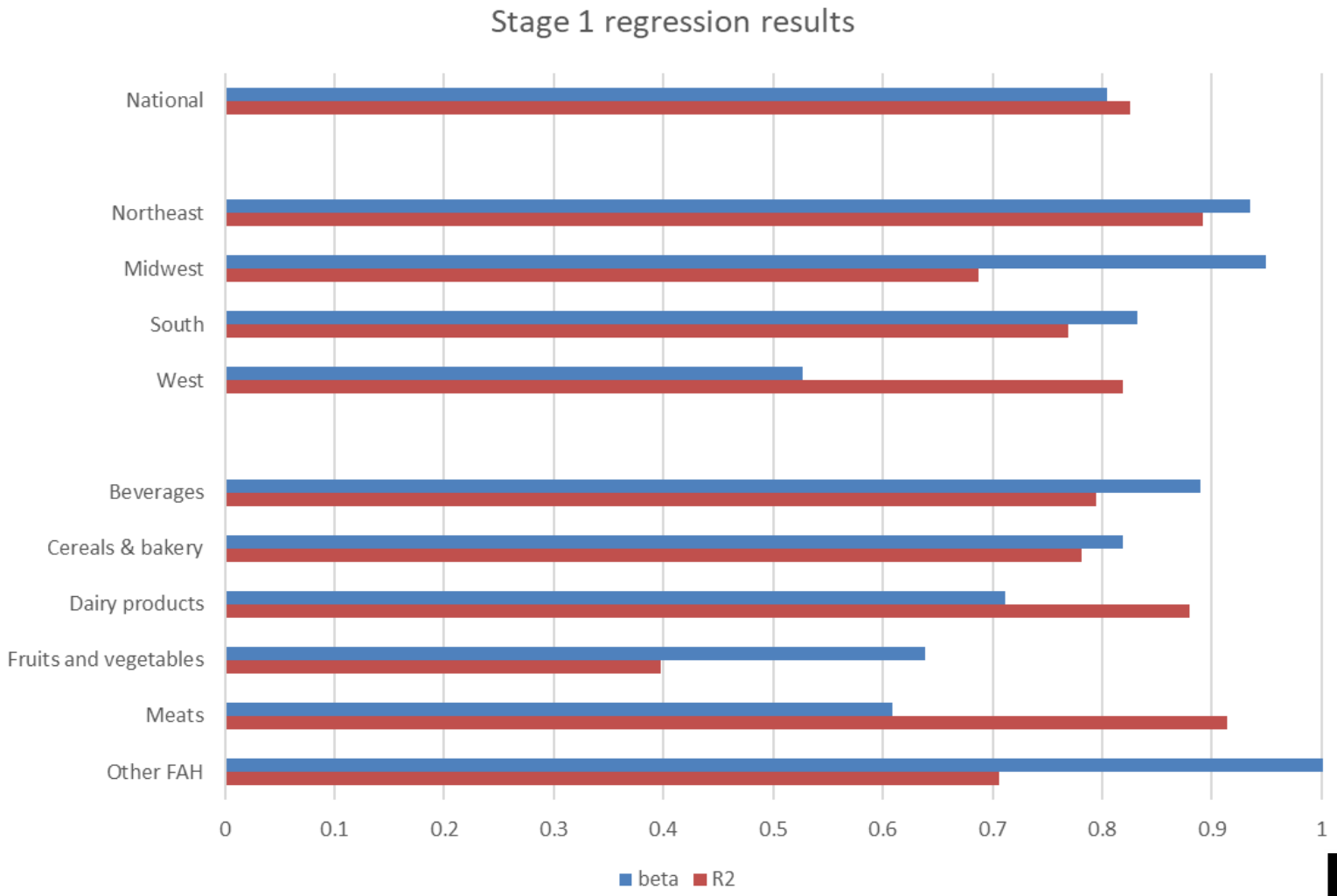
$$u^1 = \alpha + \beta P^{GML} + u^2$$

  - R^2 from stage 2 is data effect
  - 1-R^2 is the "everything-else" effect

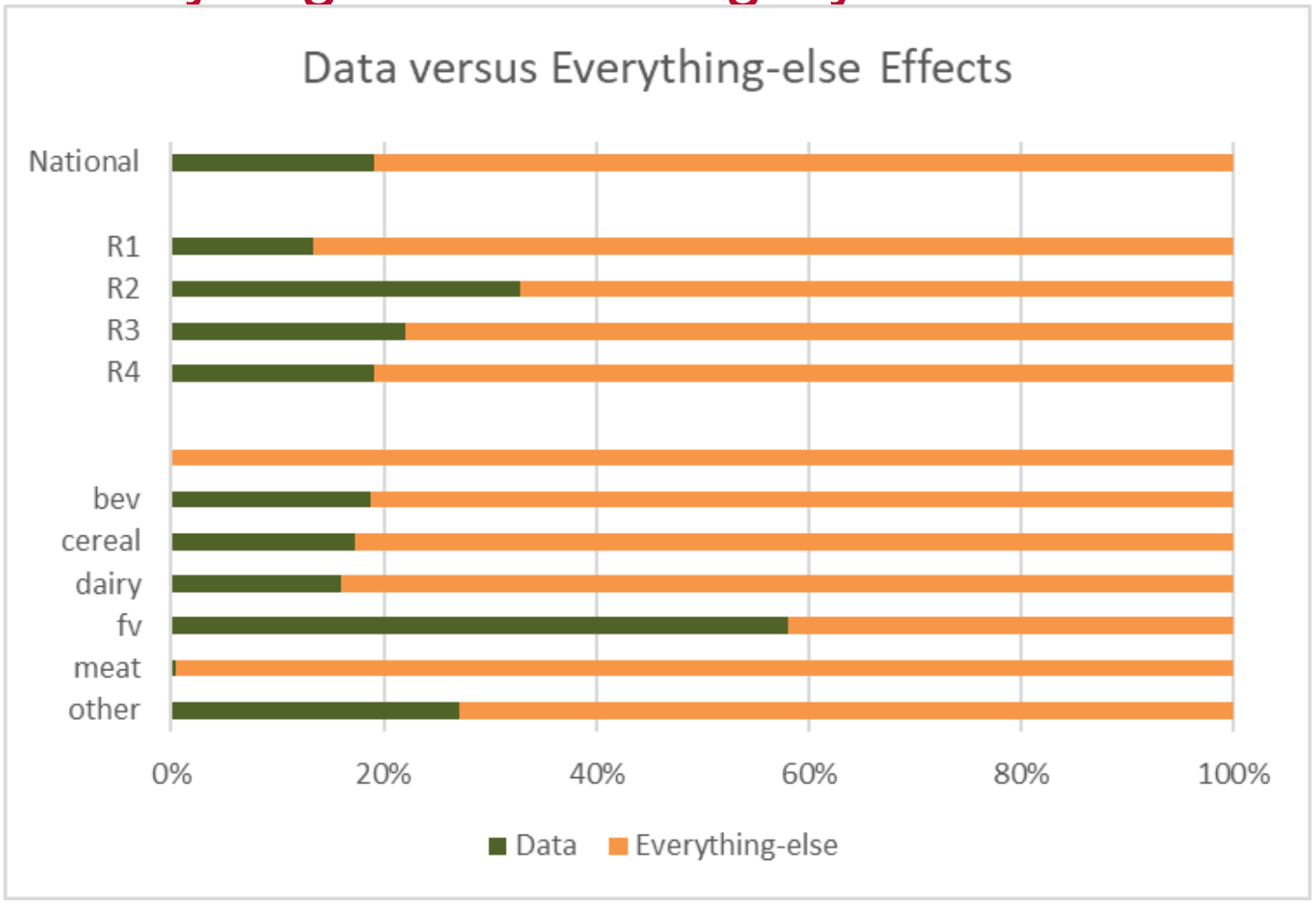
Estimate regressions separately for national FAH, 4 regional FAH, 6 national major food/beverage indices

Compare 2017 forward because of lagged weights used in construction in GML scanner price indexes

Variation in the F-MAP explained by the CPI varies by region and food category.



The different formulas explain most of the discrepancies, but its effect varies by region and category.



Limitations and Next Steps

- Current analysis examines short-run relationships → Cointegration analysis to examine long-run relationships among indexes
- Current analysis is only for 4 regions → extend analysis to 10 MSAs x 6 FAH categories
- Do these differences matter when applied in analysis? → Estimate reduced-form demand equations using CPI and F-MAP and examine differences in price elasticities