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Minding Your Ps and Qs: Going from Micro to Macro in Measuring Prices and Quantities

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Abstract
Key macro indicators such as output, productivity and inflation are based on a complex system of collection from different samples and different levels of aggregation across multiple statistical agencies. The Census Bureau collects nominal sales, the Bureau of Labor Statistics collects prices, and the Bureau of Economic Analysis constructs nominal and real GDP using these and other data sources. The price and quantity data are integrated at a high level of aggregation (product and industry classes). A similar mismatch of price and nominal variables pervades the productivity data, which use industry-level producer price indexes as deflators. This paper explores alternative methods for re-engineering key national output and price indices using transactions-level data. Such re-engineering offers the promise of greatly improved macroeconomic data along many dimensions. First, price and quantity would be based on the same observations. Second, the granularity of data could be greatly increased on many dimensions. Third, time series could be constructed at a higher frequency and on a more timely basis. Fourth, the use of transactions-level data opens the door to new methods for tracking product turnover and other sources of product quality change that may be biasing the key national indicators. Implementing such a new architecture for measuring economic activity and price change poses considerable challenges. This paper explores these challenges, along with a re-engineered approach's implications for the biases in the traditional approaches to measuring output growth, productivity growth, and inflation.

Comments
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Status quo: Balkanized data collections

- Real output:
  - Census collects the "numerator": Revenue
  - BLS collects the "denominator": Prices
  - BEA does the division: Q = P*Q/P
- Non-simultaneous collection of price and quantity
  - Stratified surveys from small and deteriorating samples
  - "Mismatch" problems
  - High cost and burden

Reengineered Sales and Prices

Challenge: Tap the firehose of transactions level now available from businesses on P and Q .

P&Q microdata
- Internet retailers
- Brick and mortar
- Aggregators

Agencies

Data products:
- GDP
- inflation

Data improvements:
- Quality change
- Timeliness
- Granularity
- Distributional statistics

Challenges: Data Collection and Measurement

Big Data

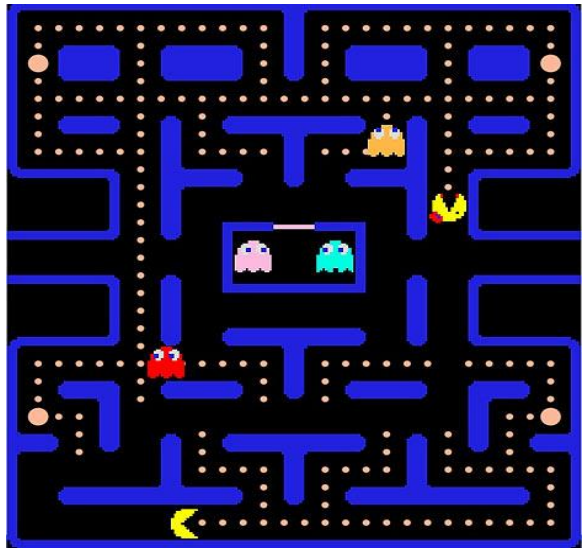
- Transactions level price, quantity and revenue data at product item level at high frequency by point of purchase (e.g., store/online)
- In this project we are working with:
  - Information aggregators: Nielsen and NPD
  - Individual retail companies in pilot projects
  - Access and agreement modes differ: Kilts Center (Booth), Census, individual company agreements with Maryland and Michigan

Extremely rapid item rotation

- Quality adjustment, noise or both?

Sorting out Product Turnover

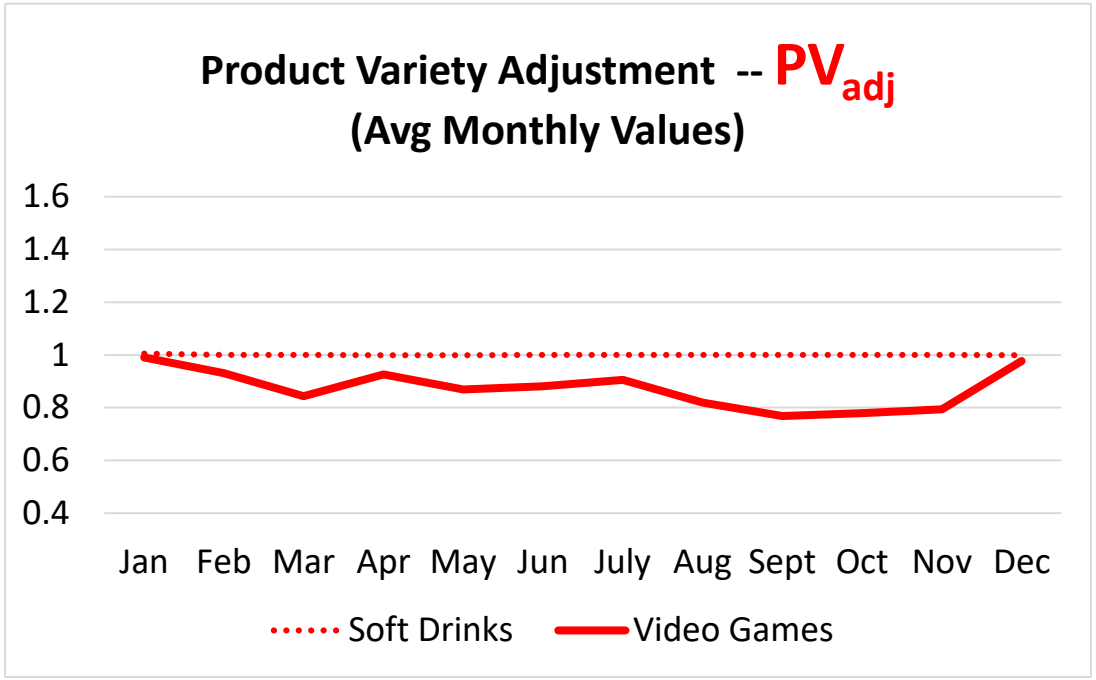
Some product turnover is just packaging and marketing.



Some reflects substantial changes in product quality

How to Sort this Out?

- Adjusting for product quality changes:
  - Expenditure function approach
    - Capture product turnover with changing expenditure shares of new vs. old goods PV_{adj} (Feenstra (1994))
    - Extend this to capturing quality change of existing goods CV_{adj} (Redding-Weinstein (2018))
  - Hedonic approach
    - At scale, not “hand-to-hand” combat

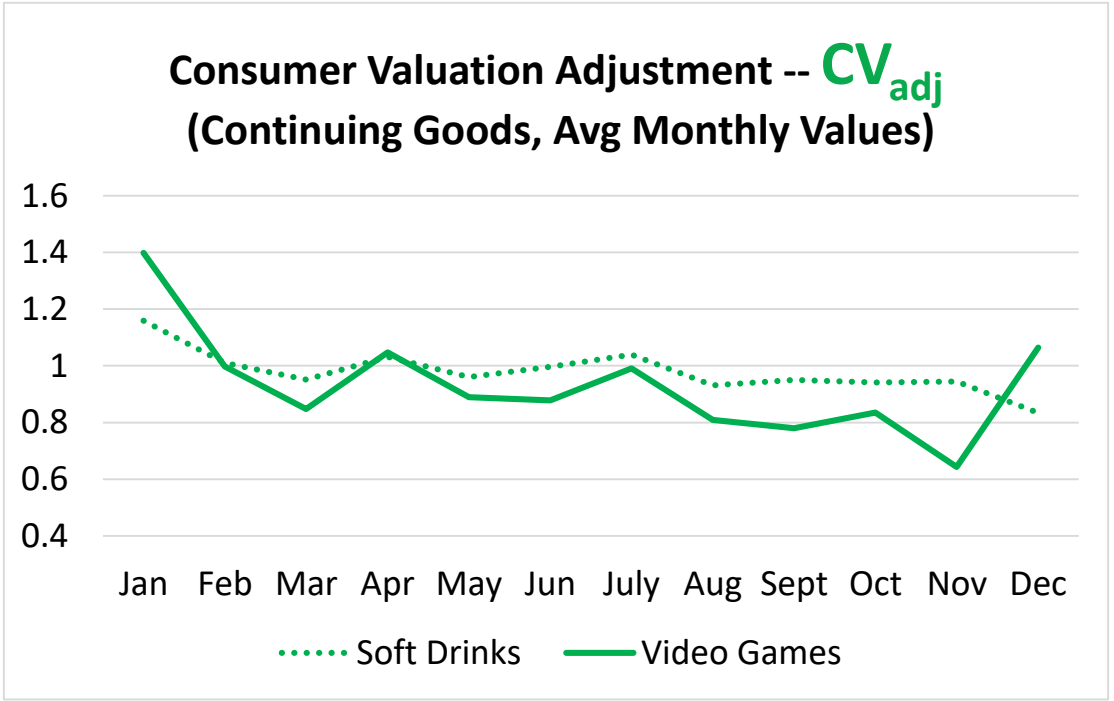


Using UPC Code Level Data from Nielsen

Soft Drinks: About 4000 products on average in a month, 90 percent are common in t-1 and t

Video games: About 3000 products on average in a month, about 83 percent are common in t-1 and t.

Nielsen data includes 1000+ product modules in 100+ product groups. Soft drinks and Video games are examples of product modules



$$\text{UPI} = PV_{adj}^{\frac{1}{\sigma-1}} \; CV_{adj}^{\frac{1}{\sigma-1}} \; \text{RPI}$$

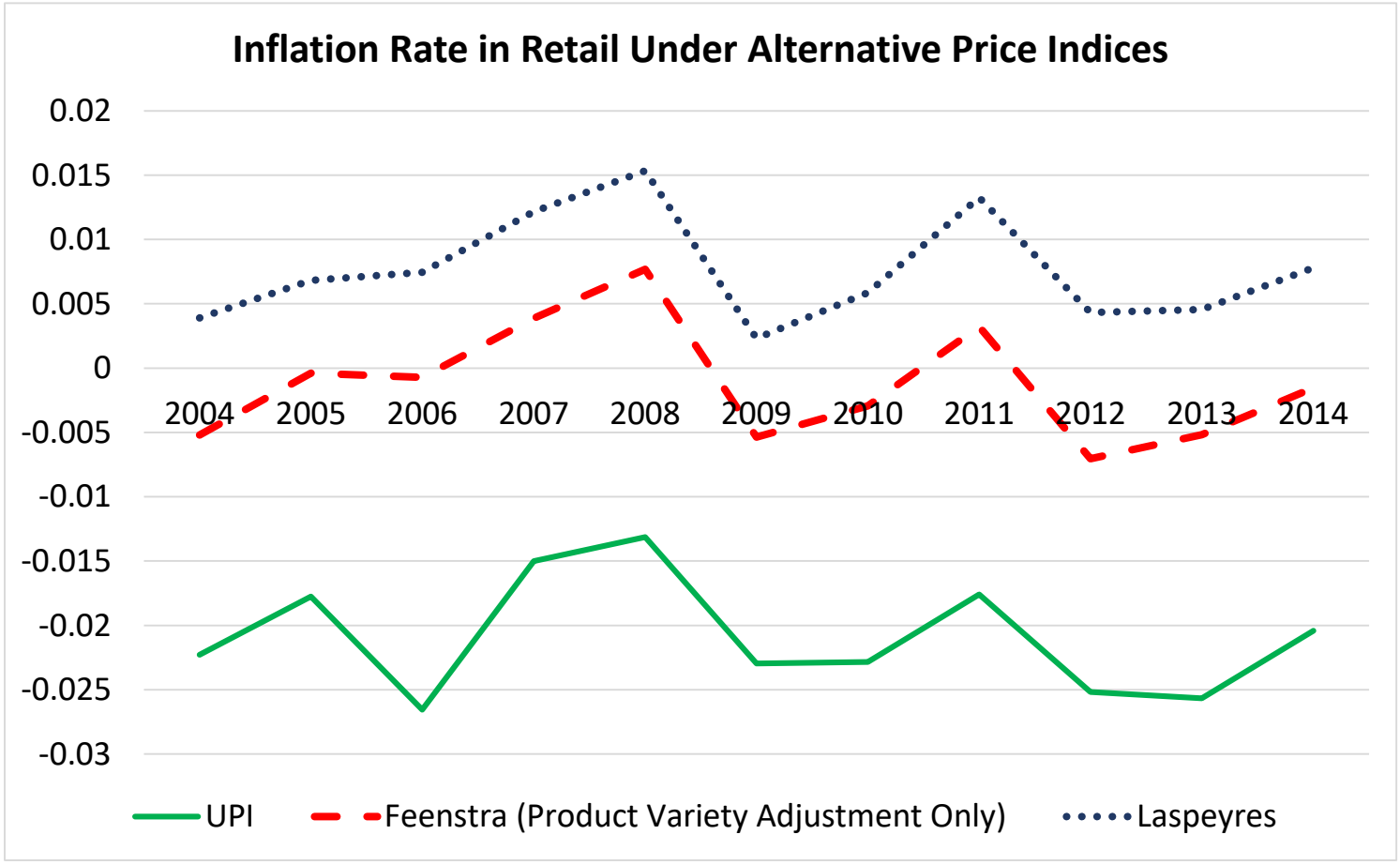
PV_{adj} = Product Variety Adjustment (Feenstra)
CV_{adj}= Consumer Valuation Adjustment (RW)
RPI = Continuing goods price index (Jevons)

σ = Elasticity of substitution.

PV_{adj} , CV_{adj} **<1 reflect improvements in Quality**

Tabulations from researchers' own analyses using Nielsen data provided by Kilts Center at Chicago Booth

Potential Impact is Very Large!



Implied inflation rate MUCH lower with both product variety and consumer valuation adjustments.

Taken at face value this implies substantially higher real output and productivity growth!

Simultaneous collection of P&Q Overcomes "mismatch" problem AND potentially dramatic improvements in adjusting for quality.

Reported values are averages of quarterly rates. Average retail inflation rate for 100+ product groups (millions of products) Weighting product groups by Divisia based expenditure shares. Tabulations from Nielsen data/Kilts Chicago Booth.

Issues to confront: Measurement and Estimation

- UPI
  - Estimation of σ
  - Level of aggregation (frequency, product group)
- Alternative: Hedonics at scale
  - Need not only P and Q but attributes.
  - Machine learning?

Issues to confront: Implementation

- Company buy in
- Heterogeneity of company information systems
- Stability/consistency of data stream
- Engineering