Communications Equipment Price Indexes:
A Look Under the Hood

Vincent Russo
Chief, Section of Durable Goods
Producer Price Index
TFI Technology Conference
January 23-24, 2020
Austin, TX

BLS
BUREAU OF LABOR STATISTICS
U.S. DEPARTMENT OF LABOR

www.bls.gov

BLS Washington Office

BLS

TOPICS

- Background on the PPI
- Theoretical model
- Index calculation and weighting
- Sampling and Collection practices
- Adjusting for product change
- Comparing adjustment methods
- Future work

BLS

Producer Price Index: What is it?

Voluntary monthly survey that measures average changes in prices received by domestic producers for their output of goods and services

- Not a cost of living index
- Not an input cost index
- Not a buyer's price index
- Not an import price index

THREE KEY POINTS

- Voluntary
  - Sampled firms can (and do ☹) refuse to cooperate with the survey, non-response
- Domestic producers
  - Imports are not in scope
  - Global production chains blur 'domestic'
- Output
  - Prices received by manufacturers
  - Not collected from buyers

BLS

HISTORY OF PPI

- First published in 1902, one of the oldest Federal economic time series
- Known as the 'Wholesale Price Index (WPI) until 1978
- Focused initially on Mining and Manufacturing Sector industries
- Now covers about 77 percent of the Service Sector economy

BLS

FACTS ABOUT THE PPI

- Covers more than 600 NAICS industries
- Includes over 17,000 sampled firms
- Tracks prices for over 60,000 unique goods and services
- About 10K indexes published monthly
  - Industry—made in one producing industry
  - Commodity--identical product produced in any industry

BLS

MAIN USES OF PPIs

- Macroeconomic indicator (economic policy, foreshadow consumer inflation)
- Deflator of national income accounts (GDP) and other time series data (productivity)
- Contract escalation
- Inventory valuation (LIFO)
- Ad-valorem taxation

PPI THEORETICAL MODEL

- Fixed-input output price index (FIOPI)
- Assumes fixed quantity, quality, and type of inputs
  - Labor
  - Capital
  - Technology

PPI THEORETICAL MODEL

- When factors of production are held constant, the revenue of a firm responds only to changes in its output prices
- Functional form: R(P, *i*, T)
  - R=revenue of the firm
  - P=output prices
  - *i*=inputs (capital, labor, materials)
  - T=state of technology

PPI INDEX CALCULATION

- PPI uses a 'modified' Laspeyres formula
- Where,
  - I_t is the price index in the current period;
  - P_o is the price of a commodity in the comparison period;
  - P_t is the current price of the commodity; and
  - Q_a represents the quantity shipped during the weight-base period.

$$I_t = (\Sigma Q_a P_t / \Sigma Q_a P_o) \times 100$$

BLS

INDEX WEIGHTING

- First stage computation (narrowly-defined product lines)
  - Items are weighted by the establishment's revenue for the product line
- Second stage computation
  - Indexes for products lines are aggregated
  - Weighted primarily by shipment values from Economic Census (collected every 5 years)

BLS

Industry 334210 At-a-Glance

Product Code	Title	2012 VOS (000)	%
334210	Telephone apparatus mfg	6,864,034	100
3342101	Telephone switching and switchboard equipment	689,372	10
3342104	Carrier line equipment & non-consumer modems	2,630,897	38
3342107	Wireline voice & data network equipment	3,543,765	52

Value of Shipments, 2012 Economic Census

BLS

Industry 334220 At-a-glance

Product Code	Title	2007 VOS (000)	%
334220	Broadcast and wireless communications equipment mfg	24,681,689	100
3342202	Broadcast, studio, and related electronic equipment	2,633,202	11
3342203	Wireless networking equipment	2,174,265	9
3342205	Radio station equipment	9,343,488	38
3342209	Other communications systems and equipment	10,530,735	43

Value of Shipments, 2012 Economic Census

BLS

SAMPLING PROCESS

- Sample by NAICS industry classification
- Business register (universe) from Unemployment Insurance System
- Probability of selection is based on employment size (proxy for output)
- Rotate samples on average 8 years, more frequently for industries with high technological change

BLS

DATA COLLECTION PROCESS

- Initiation (one-time)
  - BLS regional staff visit sampled establishments to solicit cooperation
  - Select products for the index
  - Indentify price-determining characteristics
- Repricing (monthly)
  - Respondents submit price updates
  - Washington staff evaluates microdata

ADJUSTING FOR PRODUCT CHANGE

- Aim is to remove effect of product change
- Index movement must derive from changes in price, not product attributes
- Constant quality
- Maintain fidelity to FIOPI model—inputs, technology, etc. are fixed

BLS

ADJUSTMENT METHODS

Techniques used to account for product change:

- Direct Comparison
- Explicit Quality Adjustment
- Overlap Method (implicit)
- Econometric modeling (hedonic models)

BLS

ADJUSTMENT METHODS: Direct Comparison

- Product change is minor
- No change to production cost
- E.g., blue dress replaced by red dress
- Price for new product is directly compared with price for previously specified product
- Index reflects entire price difference

BLS

ADJUSTMENT METHODS: Explicit Quality Adjustment

- Change in product *and* production cost
- E.g., new model year for motor vehicle
- Difference in production cost is assumed to be the quality change
- Respondent must provide production cost differential
- Index shows 'real' change, not nominal

Explicit Quality Adjustment Example

Base price of a new car increases from $20000 to $21000 in the new model-year.

But…

- $800 of that increase is due to extra product cost associated with new safety equipment
- Consequently, the "pure" price change is only $200
- Price inflation is 1%, not 5% (200/20000*100)=1.00

BLS

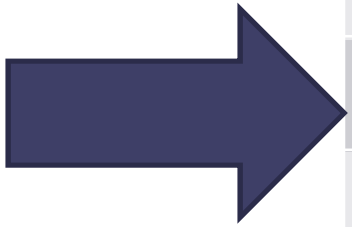
ADJUSTMENT METHODS: Overlap Comparison

- Respondent cannot provide data needed to perform explicit quality adjustment, or
- Products are too dissimilar for comparison
- Quality change accounts for entire difference in price during the 'overlap' month when PPI observes prices for both old and new products
- Index follows only the new item after the overlap month

BLS

Overlap Comparison Example

Month	Old Model Price	New Model Price	Index Δ
March	1000		
April	1050		5%
May	1000	2000	(4.8%)
June	Discontinued	2200	10%
July		2200	0



BLS

ADJUSTMENT METHODS: Overlap Comparison

Overlap comparison—continued

- Commonly used for telecom equipment and other complex product systems with bundled components
- Potential for upward bias in the index if quality improvements are understated
- Our challenge is to assign an appropriate value to the quality change

BLS

ADJUSTMENT METHODS: Hedonic regression models

- Alternative to resource cost method for products with rapid tech changes
- Determines relationships between a product's characteristics (independent variables) and its price
- Used for computers and servers
  - CPUs, memory, hard drive capacity, screen size, OS, warranty, graphics, etc.

BLS

ADJUSTMENT METHODS: Hedonic regression models

Regression quantifies the functional relationship between characteristics and a product's price

- Price is dependent variable
- Characteristics are explanatory variables

$$Price = a + b_1 x_1 + \cdots + b_k x_k + e$$

BLS

ADJUSTMENT METHODS: Hedonic regression models

- Why doesn't BLS apply hedonics more broadly? Like telecom equipment?
  - Resource constraints (staff, cost of secondary source data)
  - Appropriate and timely data sources
  - Need sufficient sample size for modeling
  - Telecom products more diversified than computers

BLS

FUTURE WORK

- Statistical machine learning techniques
  - Select model characteristics for Microprocessors (2018)
  - Using time-dummy variable
- Ongoing research in using out-of-sample cross-validation techniques
  - Network switches (Adams, Klayman)
- Hedonic model for Broadband services

BLS

FINAL THOUGHTS

- Measuring price change for high tech products presents unique challenges
- BLS benefits from external input
  - Respondents
  - Industry experts
  - Academia
  - Data users

Contact Information

Vincent Russo

Chief, Section of Durable Goods

Producer Price Index

www.bls.gov/ppi

202-691-7726

russo.vincent@bls.gov

BLS

BUREAU OF LABOR STATISTICS

U.S. DEPARTMENT OF LABOR