Communications equipment price indexes:

Another look under the hood

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Producer Price Index
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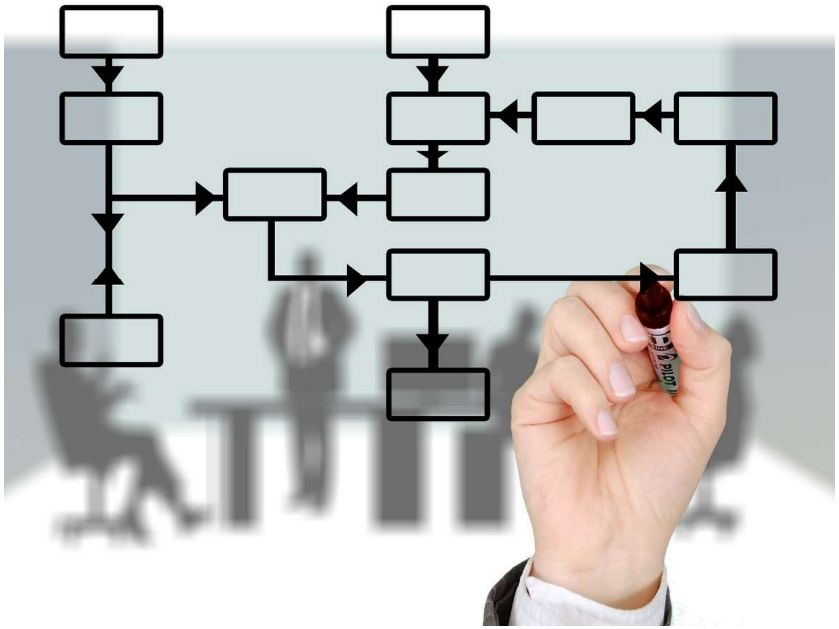
Topics

- Background on the PPI
- Theoretical model
- Index calculation and weighting
- Adjusting for product change
- Comparing adjustment methods
- Recent index trends
- Final thoughts



Producer Price Index: What is it?

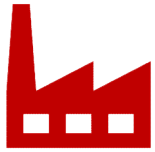
Voluntary monthly survey that measures average changes in prices received by domestic producers for their output of goods and services

- 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



Domestic producers

Imports are not in scope

Global production chains blur 'domestic'

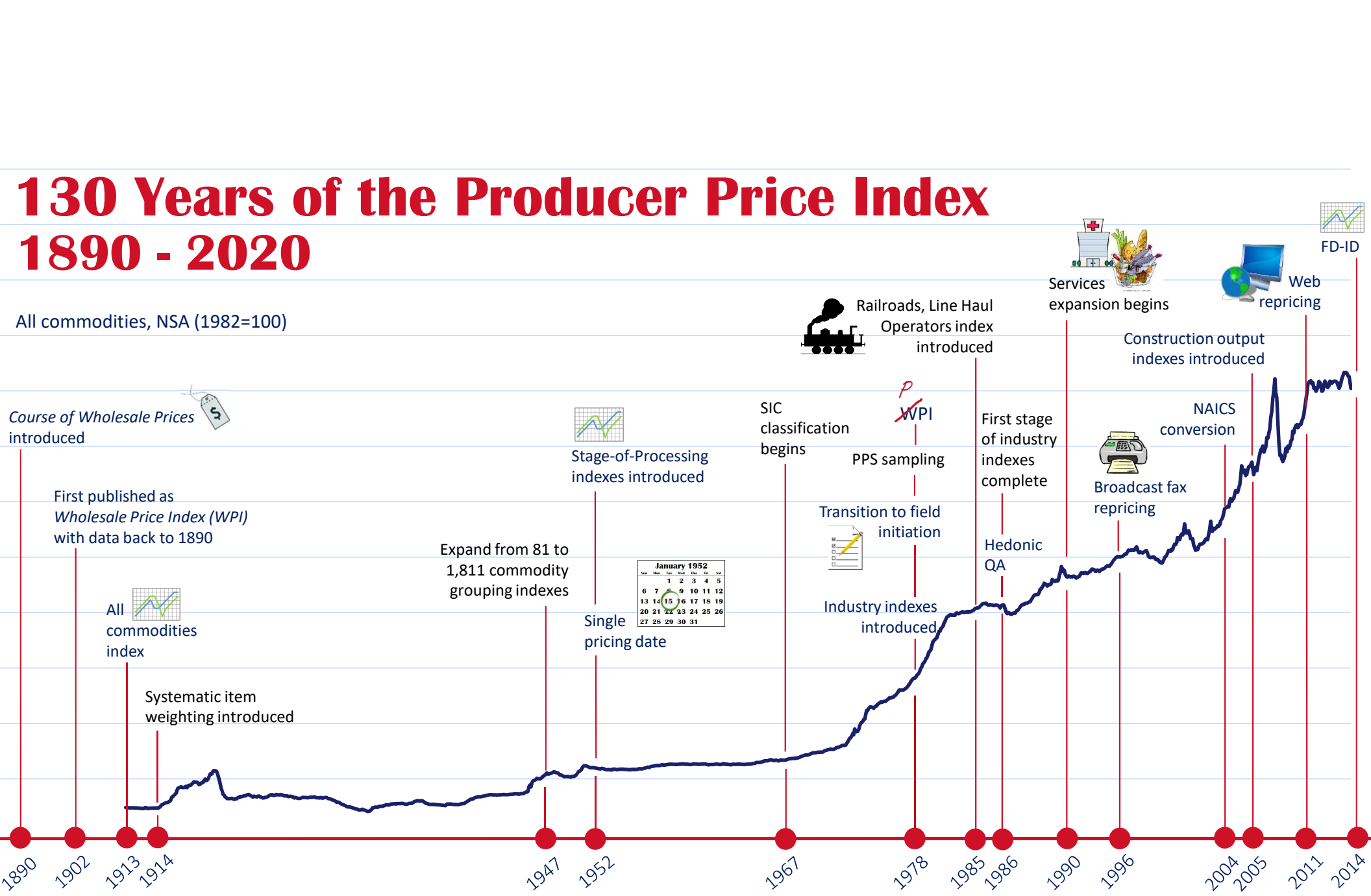
Output

Prices received by manufacturers

Not collected from buyers

130 Years of the Producer Price Index
1890 - 2020

All commodities, NSA (1982=100)



Facts about the PPI

500	• NAICS Industries
10,000	• Indexes published monthly
16,000	• Sampled firms
60,000	• Prices for unique goods and services

Main uses of PPIs

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

PPI theoretical model

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

$$I_t = \frac{\sum Q_a P_t}{\sum Q_a P_0} \times 100$$

- 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.

Industry 334210 at-a-glance

Title	2017 VOS (000)	%
Telephone apparatus mfg	5,356,767	100
Data communications equipment, incl. LAN/WAN switches, routers, and other networking equipment	4,527,469	84.5
Telephone switching and switchboard equipment	174,933	3.3
Carrier line equipment & non-consumer modems	165,409	3.1

Value of Shipments, 2017 Economic Census

Industry 334220 at-a-glance

Title	2017 VOS (000)	%
Broadcast and wireless communication equipment mfg	25,213,740	100
Broadcast, studio, and related electronic equipment	1,970,062	7.8
Wireless networking equipment	2,744,813	10.9
Radio station equipment	1,681,781	6.7
Other communications systems and equipment, incl. GPS	17,833,051	70.7

Value of Shipments, 2017 Economic Census

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

Adjustment methods

Techniques used to account for product change:

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

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

Adjustment methods: Explicit quality adjustment

- Change in product *and* production cost
  - Value of quality adjustment (VQA)
- 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

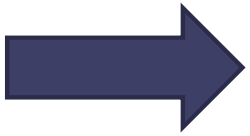
Base price of a new car increases from $20000 to $21000 in the new model-year. But…

- $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%

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

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

Adjustment methods: Overlap comparison

Overlap comparison—continued

- Commonly used for telecom equipment and other complex product systems with bundled components
- Potential for upward bias if quality improvements are understated
- Challenge is assessing value of the quality change

Adjustment methods: Hedonic regression models

- Alternative method for products with rapid tech changes
- Determines relationships between a product's characteristics (independent variables) and its price
- Used for computers, microprocessors, and broadband internet services
  - CPUs, memory, hard drive capacity, etc.
  - Speed, cache, cores, etc.
  - Download speed, provider, customer type, etc.

Adjustment methods: Hedonic regression models

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

- Price is dependent variable
- Characteristics (x) are explanatory variables
- Coefficients (b) are implicit prices

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

Adjustment methods: Hedonic model types

- Computers
  - $Price = a + b_1 x_1 + \cdots + b_k x_k + e$
- Microprocessors
  - $\log(Price) = a + \delta \mathrm{I}(t = 2) + b_1 \log(x_1) + \cdots + b_k \log(x_k) + e$
- Broadband
  - $\log(Price) = a + b_1 \log(x_1) + \cdots + b_k \log(x_k) + e$

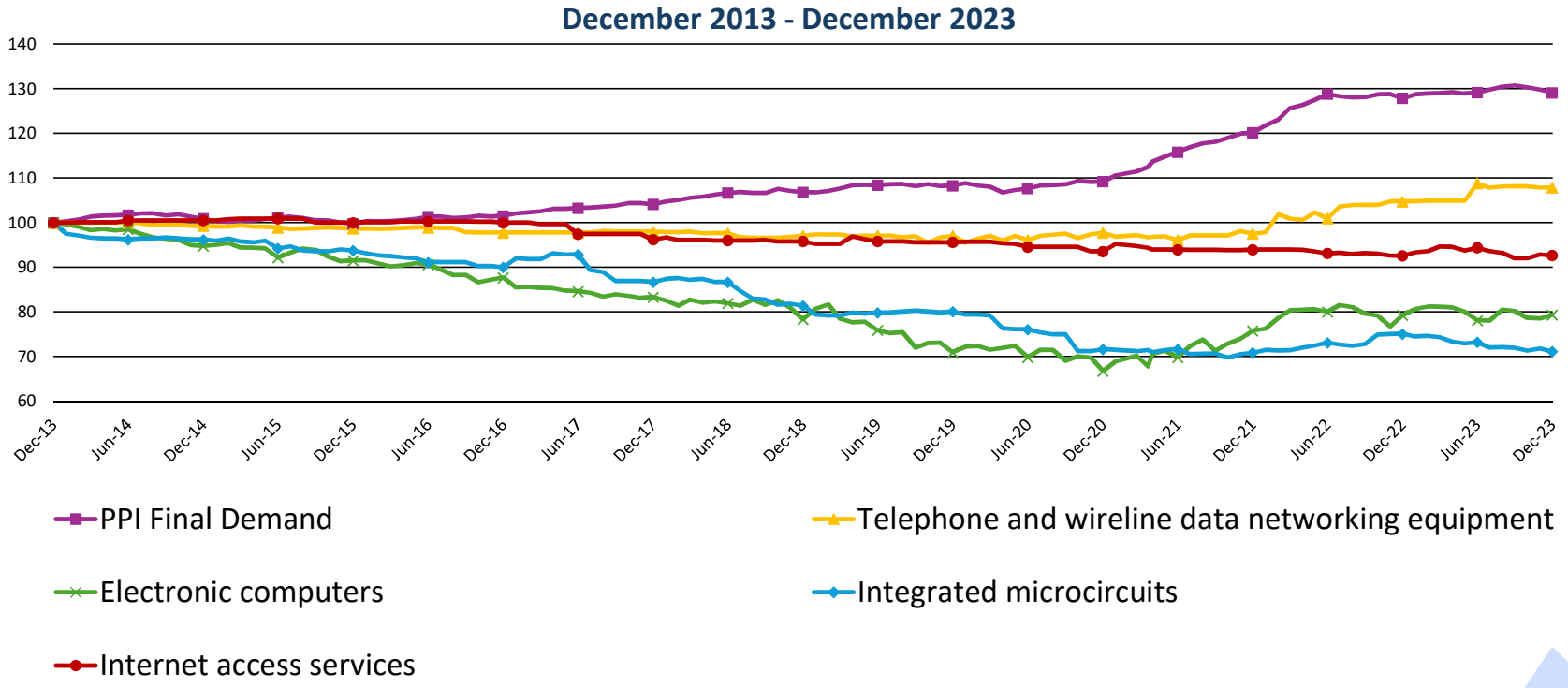
What about telecom equipment?

BLS research (Klayman, Adams) using cross-validation methods:

- Compared adjustment methods using price prediction performance
- Traditional PPI imputation methods vs. hedonics

Applying average PPI price change for similar products outperformed hedonics

Index trends for key products



Future work

- Statistical machine learning techniques
- Ongoing research in small sample techniques
- Leveraging ‘Big Data;’ alternative data sources and collection methods

Final thoughts

- Measuring price change for high-tech products presents unique challenges
- BLS benefits from external input
  - Respondents
  - Industry experts
  - Academia
  - Data users
  - Other countries
- Visit: www.bls.gov/ppi/

Contact Information

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