

# Measuring the Digital Economy at BLS: Focus on Price Index Programs

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# Overview

- “Digital economy” meaning still evolving – at BLS focus more on various issues that are often mentioned when others talk about digital economy (high-tech goods/services, Gig economy, etc.)
- Focus of this presentation on efforts in PPI and CPI programs
  - ▶ Background/context
  - ▶ PPI quality adjustment research and improvement for various high-tech goods/services
  - ▶ CPI – prevalence of e-commerce & recent quality adjustment efforts



# Price indexes “in the trenches”

## ■ Goal

- Best possible monthly indexes of price changes that meet measurement objectives and the needs of data users

## ■ Constraints on methodology

- Compatible with resources
- Computable and reviewable in 20 days
- Preserve respondent confidentiality
- Avoid undue burden on respondents
- Changes must reduce bias certainly & significantly



# Methods to account for new and improved goods and services

Method	Requires demand estimation	Based on characteristics, product or other	In production	Reason not in production
Quality adjustment from producer	No	Characteristics	Yes; PPI, MXP, CPI***	
Input from other surveys	No	Characteristics	Yes; primarily PPI	
Explicit hedonic quality adjustment	No	Characteristics	Yes; CPI*, PPI**, MXP**	
Time dummy hedonic index	No	Characteristics	No#	Restrictive assumptions
Imputed hedonic index	No	Characteristics	No	Requires larger sample sizes
Discrete choice	Yes	Characteristics	No	High computational intensity and cost; poor timeliness
Consumer surplus	Yes	Product	No	Endogeneity problems (under investigation); high cost
Disease-based price indexes	No	Treated disease	Partial; BEA and BLS experimental indexes	Do not yet adjust for differences in outcomes

\* See <https://www.bls.gov/cpi/quality-adjustment/home.htm> for CPI items that are quality adjusted using hedonic models.

\*\* PPI and MXP do explicit hedonic quality adjustment for computers.

\*\*\* For example, this is done for new vehicles in the CPI and PPI.

#PPI is currently working on first use of time dummy variable in building hedonic QA model



# PPI Quality Adjustment Research & Improvements

- Microprocessors – research & development (but almost ready for first use in production)
- Broadband Services - in production since January 2017
- Cloud computing services – in research & development



# PPI Microprocessors - Motivations

- Price trends in PPI for microprocessors (matched model methodology)
  - ▶ **2000-2009:** -33.66 percent per year
  - ▶ **2009-2014:** -6.28 percent per year
- Industry changes in recent years present measurement challenges
- Byrne, Oliner, Sichel (BOS) work using two-year overlapping time-dummy models found -42 percent per year price change, on average, from 2009-2013

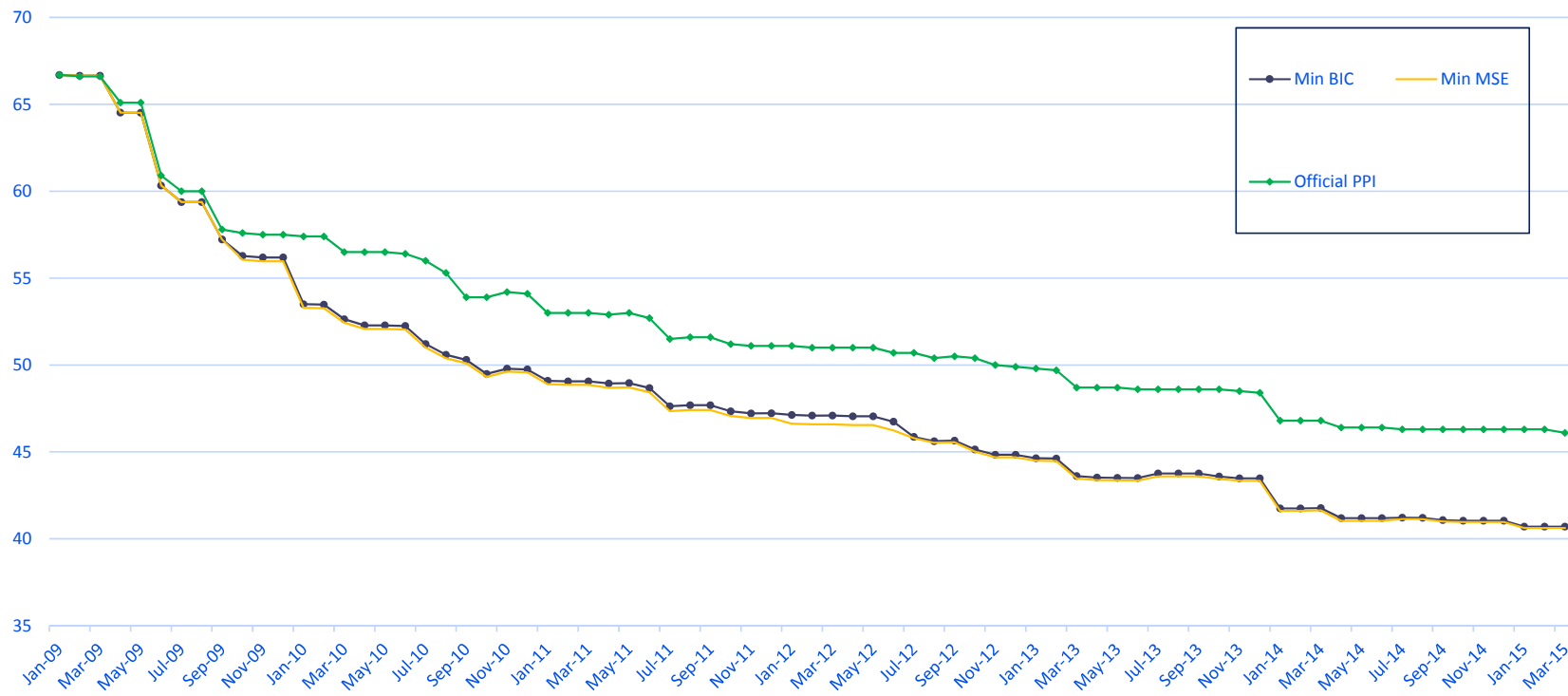
# PPI Microprocessors – R & D

- First replicated BOS model with data available to PPI
- Used data set to explore BOS results
- Looked at other product characteristics besides performance benchmark focused on by BOS
- Developed PPI microprocessor hedonic model
  - ▶ Based off BOS methodology
  - ▶ Use quarterly data for 2009-2017
  - ▶ Replace SPEC benchmarks with PassMark benchmark
  - ▶ Modified BOS use of “early prices” to include all microprocessors introduced within 15 months of a given quarter



# Results: Counterfactual indexes – Microprocessors

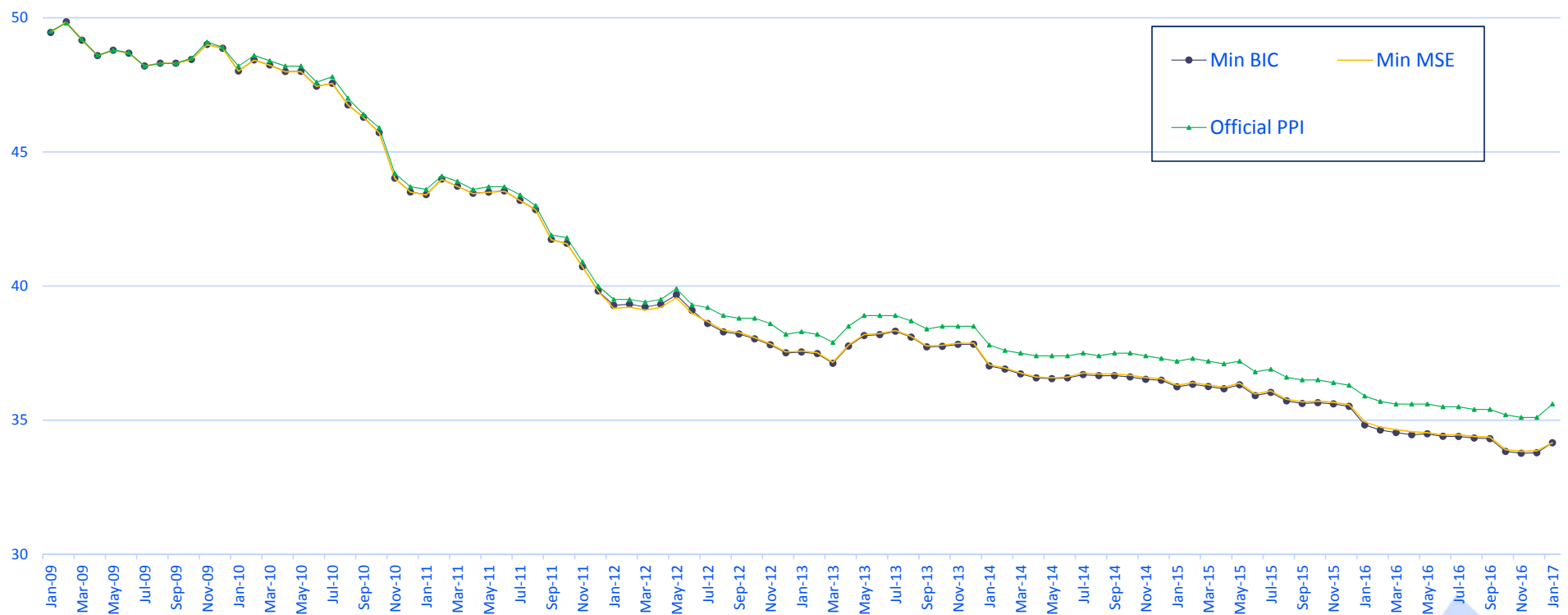
## Microprocessors





# Results: Counterfactual indexes – Semiconductors

## Semiconductors - Primary Products



# PPI Microprocessors – Next Steps

- Results shown today reflect updates from CRIW summer workshop feedback & subsequent discussions
- Made some adjustments in approach but nothing major
- Getting ready to introduce new hedonic model for microprocessors in production soon
- Novel approach for PPI and BLS
  - ▶ First use of a time dummy hedonic model & application of statistical learning methods in PPI
  - ▶ Potential template for hedonic QA for other industries that see rapid technological change



# PPI – Broadband Services

- With release of PPI data for December 2016, began using hedonic QA for broadband items with PPI for internet access services (DSL, cable, & fiber optic services)
- Rapid technological change – need to determine VQA for increased broadband download or upload speed
- Hard to get information from survey participants so developed and now use hedonic model to estimate
- Plan to re-estimate model annually



# PPI – Cloud Computing

- R & D on hedonic QA model for cloud computing
- Use product & price data from Amazon Web Services (AWS), Microsoft Azure, & Google Cloud
- Impacts PPI for *Hosting, ASP, & other IT infrastructure provisioning services*
- So far developed preliminary linear model to derive MSE for several price determining characteristics

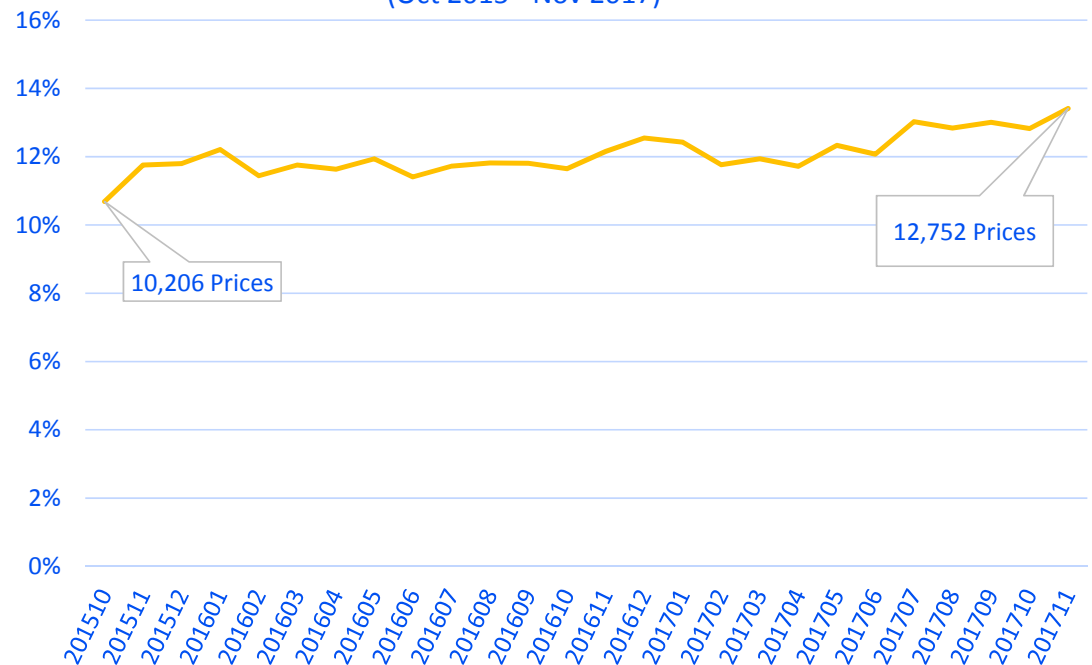


# CPI – E-Commerce Statistics

	Quarterly Retail Sales (Census)	TPOPS Sample Frame*	CPI C&S Initiation Sample (Feb and Aug)	Initiation Sample Name
2015 Q4	7.5%	8.6%		
2016 Q1	7.8%	9.6%	8.1%	Feb16
2016 Q2	8%	9.6%		
2016 Q3	8.2%	8.7%	9.2%	Aug16
2016 Q4	8.2%	8.9%		
2017 Q1	8.5%	10.2%	8.3%	Feb17
2017 Q2	8.9%	9.2%		
2017 Q3	9.1%	8.5%	10.9%	Aug17

\*TPOPs value is a percentage of eligible outlets reported (denominator excludes garage sales, commissaries, etc. that are not eligible in CPI).

Percent of CPI Field Collected Data that is collected via the Web  
(Oct 2015 - Nov 2017)



# CPI Quality Adjustment Research & Improvements

- Collaboration with BEA – focus on new data sources/ division of labor
- Wireless telephone services
- Cell phones
- Cable, internet, & landline (“wireline services”)



# CPI: Wireless Telephone Services

- Refined quality adjustment process in early 2017, reducing the rate of non-comparable substitution
  - ▶ Better estimation of price of data plans with included data amounts not offered to customers in previous period using data from Whistle Out site
- Work with JD Household data shared by BEA
  - ▶ Potential to guide field item selection procedures & substitution frequency
- Research Whistle Out data for potential data collection replacement



# CPI: Cell Phones

- Using datasets from BEA, BLS built a new QA hedonic model—targeted for introduction in production starting in January 2018
- Directed substitutions 2x/year, as major new smart phone models are released (5/2018 for first)
- QA hedonic models will be updated twice yearly to correspond with release dates



## CPI: Cable, Internet, & Landline (“wireline services”)

- Researching alternative data set shared by BEA
  - ▶ Cover standalone and triple-play bundled versions of these wireline services
  - ▶ Potential for development of QA models if viable
  - ▶ Potential for replacing/supplementing data collection
- JD Household data may be helpful here too
  - ▶ Improve field procedures (item selection & substitution frequency)

# Conclusions

- One potential drawback – offer prices vs. transaction prices in data sources
- Many similar challenges to use of other alternative data sources (cost of data to refresh models, can be labor intensive, etc.)
- Obtaining corporate data may still be the best answer if possible
- Will continue efforts to improve our price measurement of digital economy-related areas



# Contact Information

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# Other Slides supplementing main presentation in case they are needed

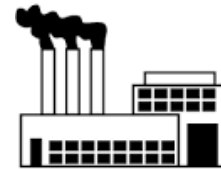


# Overview of BLS Price Indexes

- **Consumer Price Index (CPI)**—prices paid by urban consumers



- **Producer Price Index (PPI)**—prices received by domestic producers



- **Import and Export Prices (MXP)**—prices related to trade between US & rest of world



## Impact of estimated biases to Personal Consumption Expenditures deflators on measured real GDP growth, 2000-2015

Expenditure Category	Share of GDP				Lebow-Rudd est. bias
	2000	2005	2010	2015	2003
Selected PCE categories					
Medical care:					
Prescription drugs	1.3%	1.6%	1.9%	2.3%	1.20%
Nonprescription drugs	0.2%	0.2%	0.3%	0.3%	0.50%
Medical care services*	9.8%	10.9%	12.2%	12.5%	0.76%
PC services (incl. internet)**	0.2%	0.2%	0.4%	0.6%	6.50%
Medical care:	<b>Contributions to real GDP growth (percentage points per year)</b>				
Prescription drugs	-0.02	-0.02	-0.02	-0.03	
Nonprescription drugs	0.00	0.00	0.00	0.00	
Medical care services	-0.07	-0.08	-0.09	-0.09	
PC services (incl. internet)	-0.01	-0.01	-0.03	-0.04	
All other PCE categories	-0.10	-0.10	-0.10	-0.09	
<b>All PCE categories</b>	<b>-0.20</b>	<b>-0.22</b>	<b>-0.24</b>	<b>-0.26</b>	

\* Bias estimate for medical care services has been adjusted based on data from AHRQ (2017).

\*\* Bias estimate for PC services (including internet) is based on Greenstein and McDevitt (2011).

NOTE: Total for All PCE categories may not add exactly to the sub-components shown in the columns due to rounding.



## Impact of estimated biases to Private Fixed Investment deflators on measured real GDP growth, 2000-2015

Equipment type	Share of GDP				Byrne, Fernald, and Reinsdorf estimated bias	
	2000	2005	2010	2015	1995–2004	2004–2014
Communication equipment	1.2%	0.7%	0.6%	0.6%	5.8%	7.6%
Computers and peripherals	1.0%	0.6%	0.5%	0.4%	8.0%	12.0%
Other info. systems equipment	0.7%	0.7%	0.7%	0.8%	8.3%	5.4%
Software	1.8%	1.7%	1.7%	1.8%	1.4%	0.9%
	<b>Contributions to real GDP growth (percentage points/year)</b>					
Communication equipment	-0.07	-0.04	-0.03	-0.03		
Computers and peripherals	-0.08	-0.05	-0.04	-0.03		
Other info. systems equipment	-0.05	-0.06	-0.06	-0.06		
Software	-0.03	-0.02	-0.02	-0.03		
<b>All PFI categories</b>	<b>-0.23</b>	<b>-0.17</b>	<b>-0.16</b>	<b>-0.15</b>		

Note: The contributions to GDP growth for 2000 and 2005 are calculated using the bias estimates for 1995–2004; the contributions for 2010 and 2015 use the bias estimates for 2004–2014. Total for All PFI categories may not add exactly to sub-components shown in columns due to rounding.



# A PPI Perspective: Growth in NAICS 454110

## 454110 Electronic and Mail Order Shopping Value of Shipment (VOS) Data

	454110 VOS	Retail Trade VOS	% of Retail Trade VOS	In Scope VOS	% of In Scope VOS
2012	\$122,409,558	\$1,206,742,161	10.1438%	\$23,397,286,985	0.5232%
2007	\$87,547,853	\$1,175,745,286	7.4462%	\$21,793,963,662	0.4017%



## CPI – Prevalence of E-Commerce

- For first five months of 2017, 12.1% of item/price data collected by field was from the internet (“Web”) – compared with 11.9% for all twelve months in 2016
- ??% of data collected in National Office was also from “Web”
- As of Q3 2016, E-COMM percent in TPOPS Sample Frame was 8.0%, 8.1% in C&S Initiation Sample

*(NOTE: This info is preliminary – subject to update by FESAC meeting.)*