

# How Much is US Labor Productivity Revised?

Peter B. Meyer, Kendra Asher, John Glaser,  
Jay Stewart, and Jerin Varghese

Authors did the work at U.S. Bureau of Labor Statistics  
Asher now at U.S. Bureau of Economic Analysis

Views and findings are those of the authors, and do not necessarily reflect the views of the Bureaus

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# Labor productivity definition

- LP = Labor Productivity = 
$$\frac{\text{Output (BEA)}}{\text{Hours Worked (BLS)}}$$
- We focus on U.S. nonfarm business labor productivity statistics
  - About 75% of GDP, excluding general government and nonprofits
  - Hours worked by matching workforce
- The data sources are revised over time.
  - Mostly “transitory uncertainty;” Some is definitional or change in procedure.
  - Related studies: Aruoba (2008), Sinclair and Stekler (2013), Manski (2015), Jacobs and van Norden (2010, 2016), Fixler et al (2018), Galvao et al (2019), our new Asher et al (2021)

# Definitions

- Hours, output, labor productivity, measured as quarter-to-quarter growth
  - ▶ A figure for Q1 is a change from the previous Q4
  - ▶ Shown an annualized figure, often 1-3%
- Reference quarters: 1995-2020, selected in different charts
- We have snapshots at each news release: 8 per year
  - ▶ *Estimates* are associated with releases, denoted R0, R1, R2, . . . . R40
  - ▶ At each release, we have a new estimate for previous quarters
- *Revisions are changes in estimates* between releases
  - ▶ Revisions are measured as means of arithmetic differences of log growth rates
  - ▶ E.g. if LP growth is revised from 1.8 in R0 to 2.0 in R2 release, then revision is .2

# Timing of News Releases

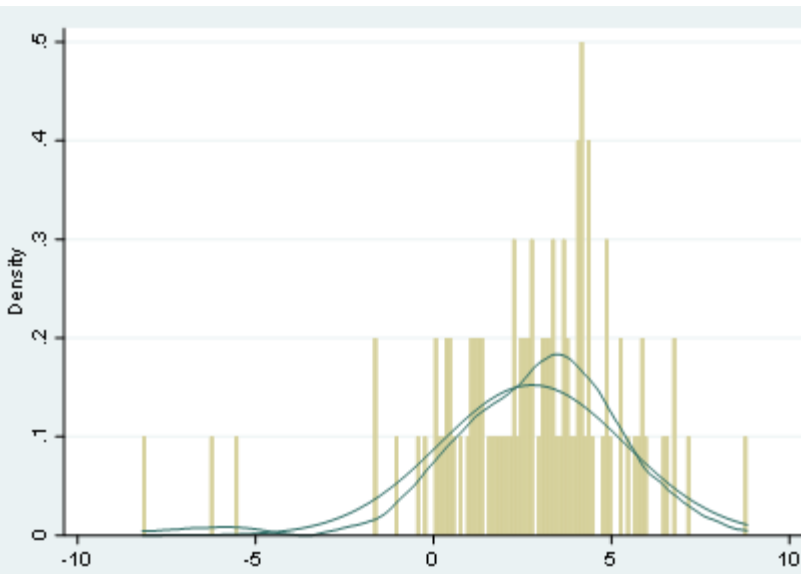
- Our quarterly news release reports LP growth
  - First estimate, R0, released ~40 days after reference quarter
  - Second estimate, R1, released ~30 days after R0
  - Third estimate, R2, released ~60 days after R1, with next quarter's R0
  - Subsequent revised estimates are available: [bls.gov/lpc](https://bls.gov/lpc)
- We focus here on R0, R2, and R40 for each quarter
  - The first estimate, next quarter's estimate, & 5 years out



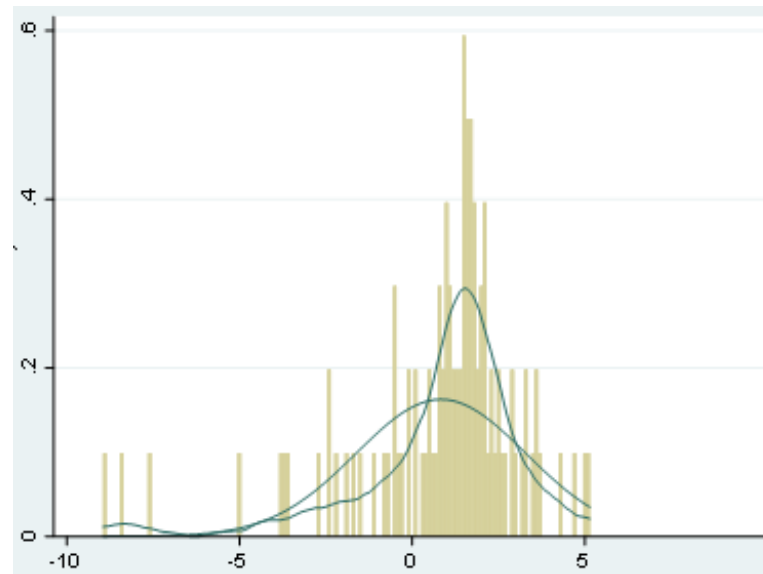
# Distributions of growth rates

- Charts show underlying quarterly variables are distributed at R0, before revisions
  - N=100; reference quarters 1995-2020Q1; all variables are annualized growth rates
- Output growth is roughly normal, with some skew and downward tail, mean 2.77%
- Hours-worked is peaked, tightly clustered around mean .83%
- Resulting Labor Productivity growth is a bit peaked, with mean 1.96%

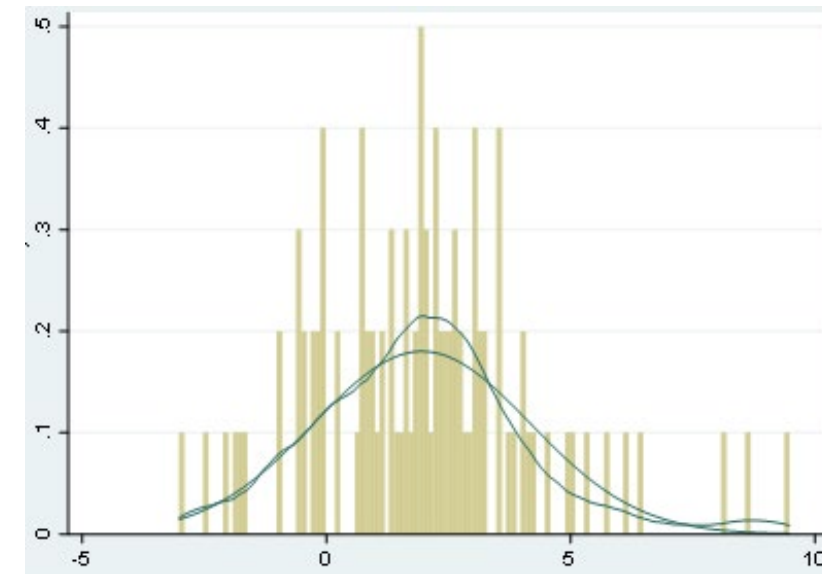
Output growth



Hours-worked growth



Labor productivity growth



# Summary statistics of variables

- These are *averages of growth rates*
- Effects of revisions
  - Raise then lower output and labor productivity estimates
  - Hours estimates drift down
  - The distributions spread out; std dev up
- Reference quarters 1995-2014

	LP at R0	LP at R2	LP at R40
Mean	2.27	2.40	2.05
Std. dev.	2.19	2.51	2.72
Min	-2.05	-4.45	-3.39
Max	9.45	9.50	10.34

	Output at R0	Output at R2	Output, R40
Mean	2.98	3.05	2.66
Std. dev.	2.65	3.09	3.45
Min	-8.19	-8.84	-12.03
Max	8.80	10.40	11.01

	Hours at R0	Hours at R2	Hours at R40
Mean	.73	.66	.62
Std. dev.	2.65	2.60	2.90
Min	-8.95	-9.04	-10.15
Max	5.06	4.88	4.56

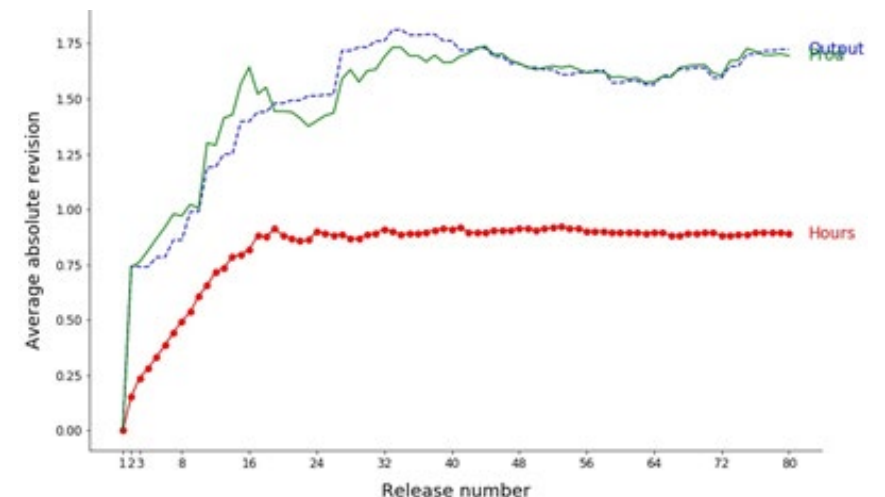
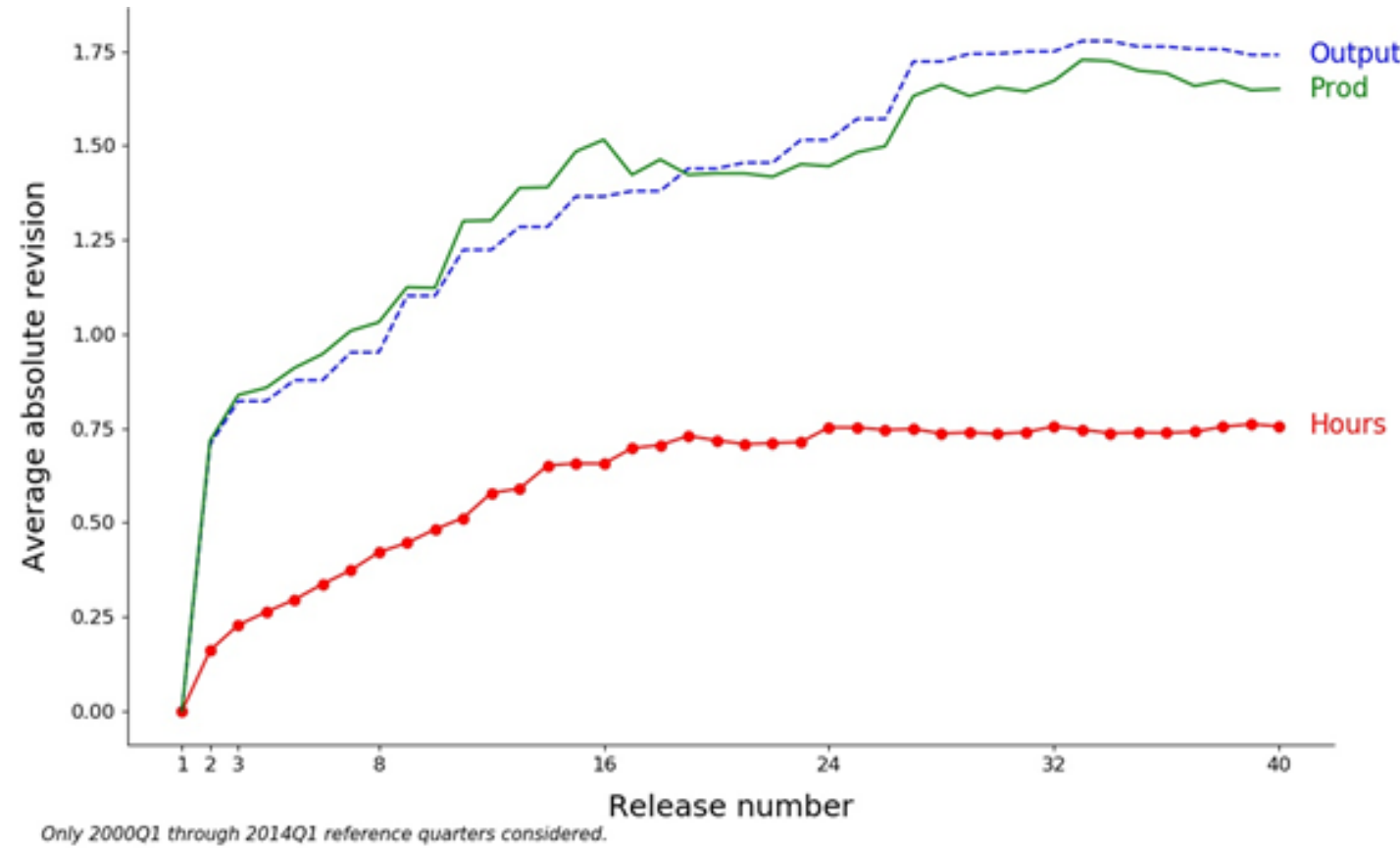
# Magnitude of revisions over time

- Shown: absolute values of revisions averaged over reference quarters
- Hours-worked estimates avg change .75%
- Output and LP estimates avg change: 1.7%

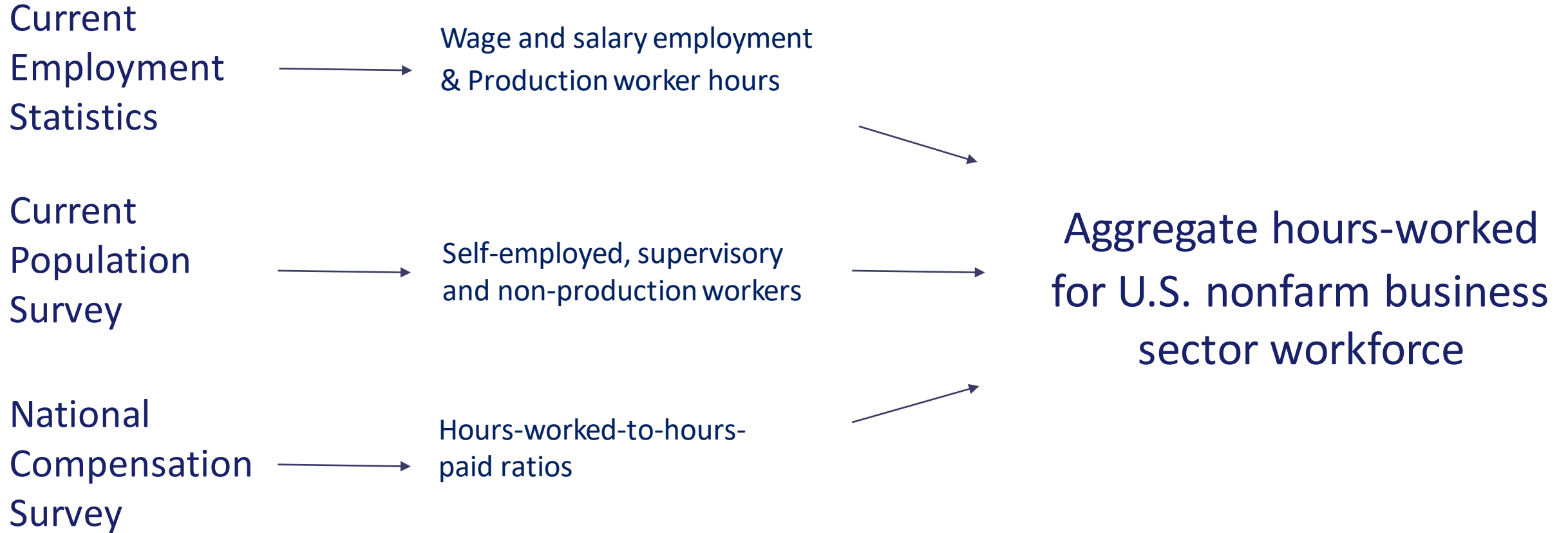
- Lower chart has 10 years of revisions
- ➔ 2000-2008 reference quarters
- ➔ After 5 years, revisions are small.

Top chart data: 2000-2014Q1 reference qtrs.

Lower chart: 2000-2008 data



# Data flow for hours-worked estimates



Here we'll focus on statistical properties of the aggregate.



# Sources of Revisions

- Additional data in sources (GDP and CES)
- Benchmarking of CES to QCEW
- Updating of seasonal adjustment in GDP, CES, CPS
- Annual revisions to GDP data
- Methodology changes to hours-worked
- Comprehensive revisions to GDP data (every 5 years)



# Calendar of Releases

LP releases occur each Feb., March, May, June, Aug., Sept., Nov., and Dec.

- Every release has new data on both output and labor
- Two releases per quarter
- Every release has either an R0 estimate and an R2, or an R1

Largest revisions occur on regular annual schedules.

- March incorporates the CES benchmark revision of previous year
- August release incorporates the annual NIPA/GDP benchmark revisions, and any comprehensive revisions to GDP

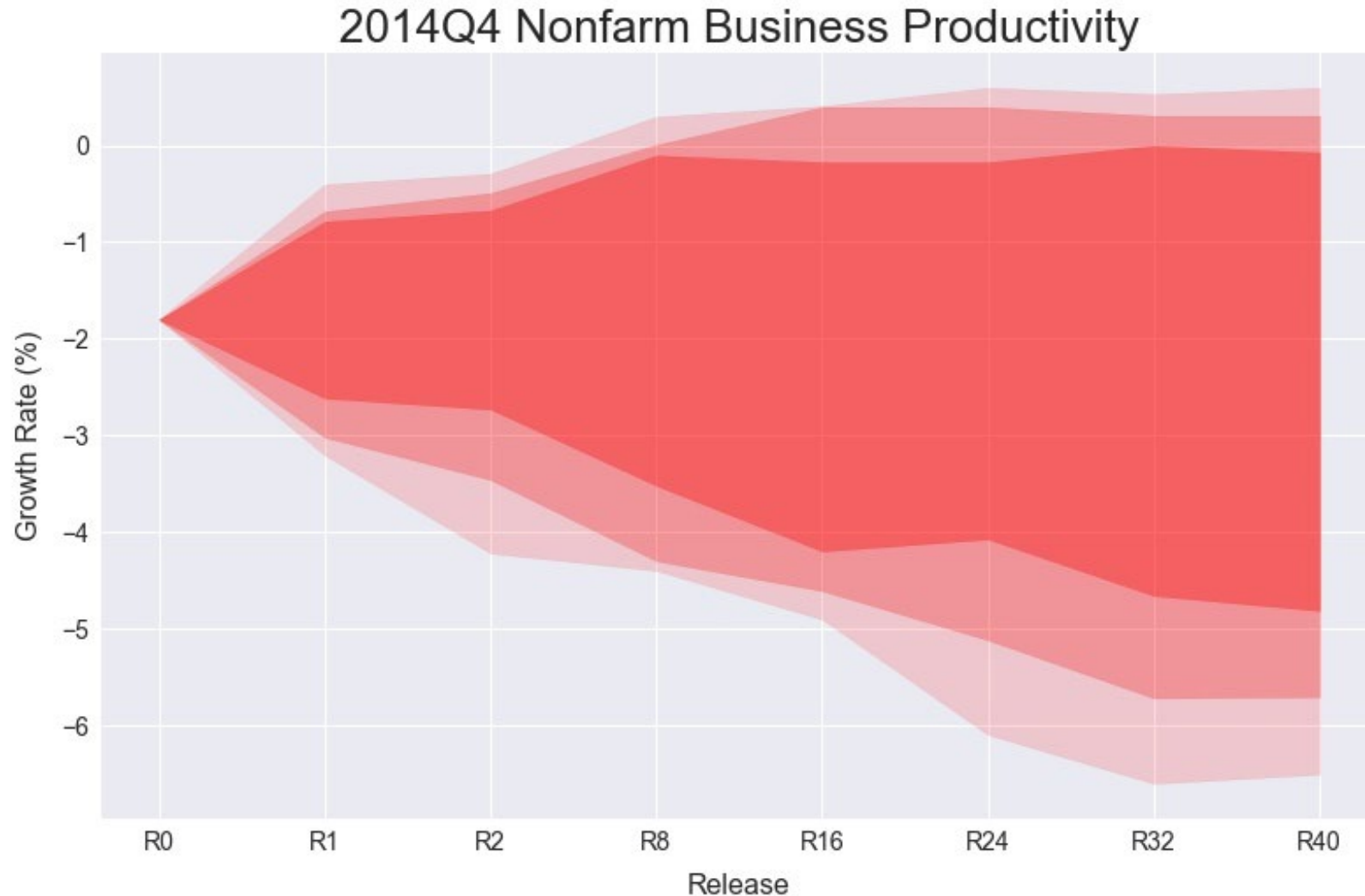
# Prediction intervals: 70, 80 and 90% ranges

The point at the left is a first estimate of labor productivity

An expanding range covers ranges of likely future estimates, based on 20 prior years of revisions.

The dark region is 70% prediction interval; the others are 80% and 90%

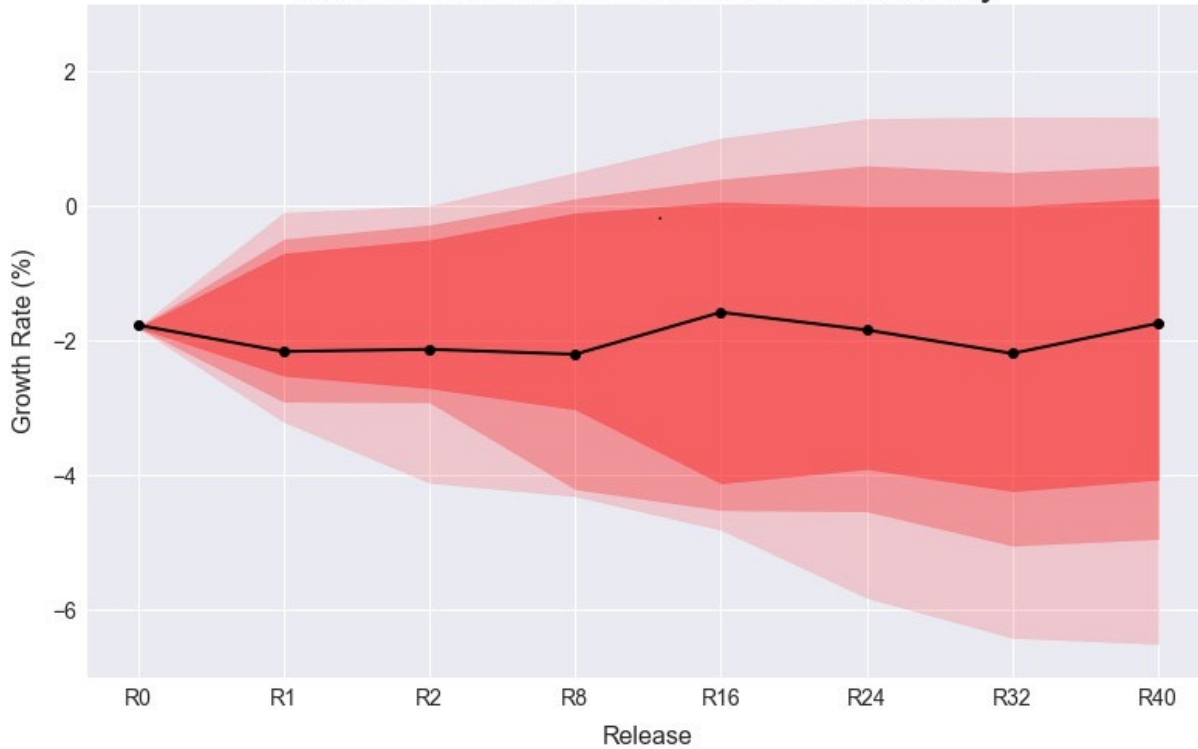
Revisions down have more spread than revisions up.



Prediction intervals are shown at 70%, 80% and 90% confidence.

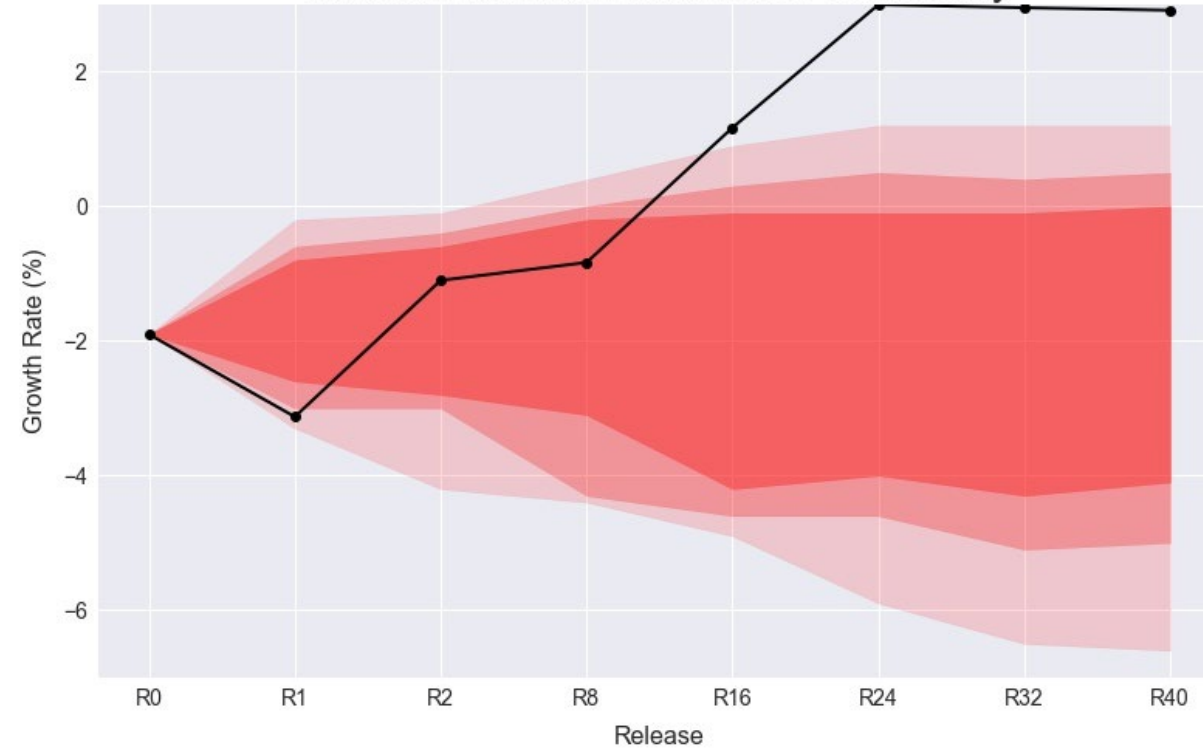
# Historical paths for a reference quarter

## 2014Q4 Nonfarm Business Productivity



Prediction intervals are shown at 70%, 80% and 90% confidence. Period used is 1995Q1 through 2014Q3.

## 2015Q1 Nonfarm Business Productivity

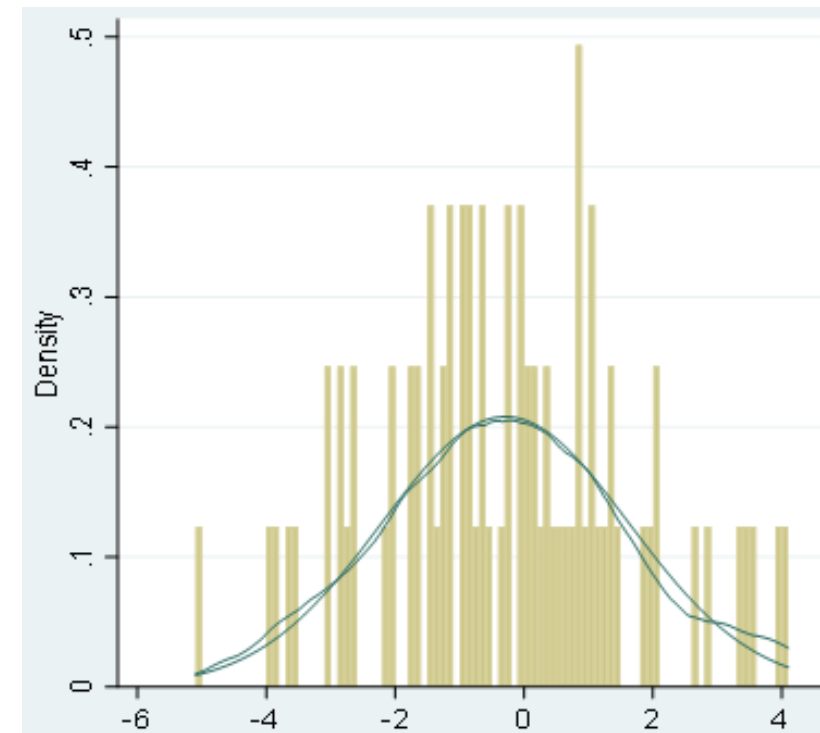
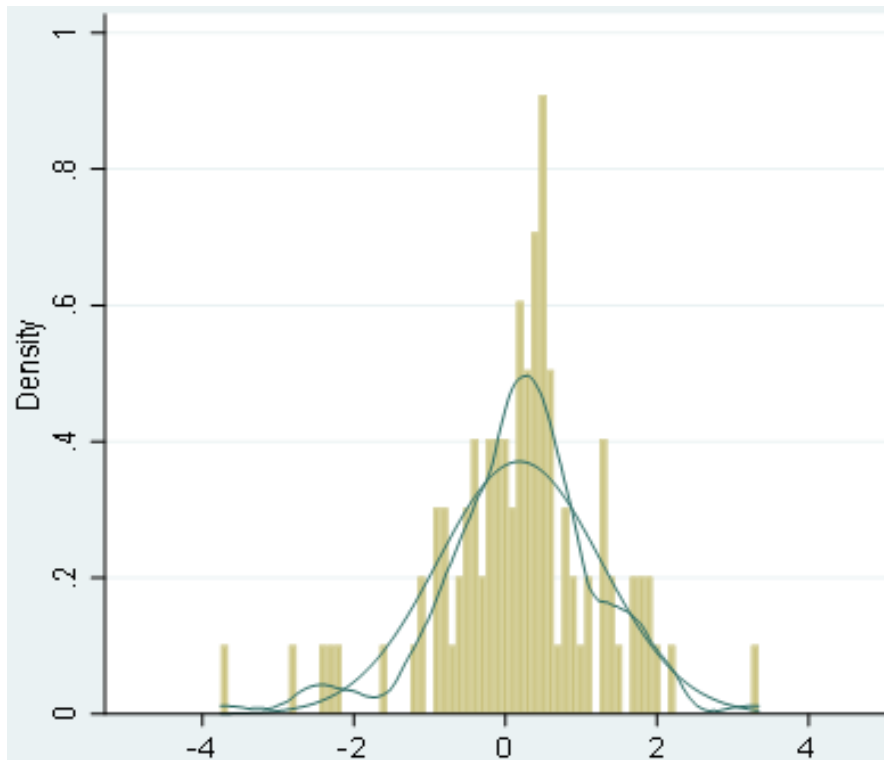


Prediction intervals are shown at 70%, 80% and 90% confidence. Period used is 1995Q1 through 2014Q4.

# Distribution of Revisions to Productivity

Revisions to LP growth in the first 3 months (R0 to R2) are peaked, with mean of .18  
Reference quarters 1995-2020 (N=99)

Revisions from R2 to R40, 5 years later, are normally distributed, with mean of -.29  
Reference quarters 1995-2015 (N=81)



# Draft text for R0 news releases

**SIZE OF REVISIONS:** Productivity and cost measures are revised on a regular schedule as more complete data become available. The first estimate is published within 40 days of the close of the reference quarter, the second estimate approximately 30 days later, and the third estimate approximately 60 days after the second estimate.

**Based on past revisions, the third estimate of nonfarm business sector quarterly labor productivity growth has differed from the first estimate by ??? to ??? percentage point about 80 percent of the time. This interval is based on estimates for reference quarters from the first quarter of 2001 to the fourth quarter of 2020.**

For more about revisions to labor productivity growth see “How large are revisions to estimates of quarterly labor productivity growth?” at

<https://www.bls.gov/osmr/research-papers/2021/ec210040.htm>.

# Decomposition of Revisions

- LP growth can be approximated as:

$$LP\ Growth_{t-1,t} \approx [\ln(Q_t) - \ln(Q_{t-1})] - [\ln(L_t) - \ln(L_{t-1})]$$

- where Q and L are indexes of output and hours

This gives us a simple additive framework to analyze revisions

- $Revision = LP\ Growth_{t-1,t}^{R2} - LP\ Growth_{t-1,t}^{R0}$



# Decomposition of R0-to-R2 Revisions

	Average Revision to:				Total
	Output		Hours		
	Current Quarter	Previous Quarter	Current Quarter	Previous Quarter	
All Quarters	-0.16	-0.27	-0.06	-0.05	0.13
Q1	-1.29	-1.01	-0.15	-0.12	-0.25
Q2	0.25	-0.13	-0.11	0.00	0.49
Q3	0.38	0.02	0.32	0.18	0.22
Q4	0.04	0.04	-0.32	-0.25	0.07

→ Revisions to Q1 output growth incorporate large revisions to the previous Q4

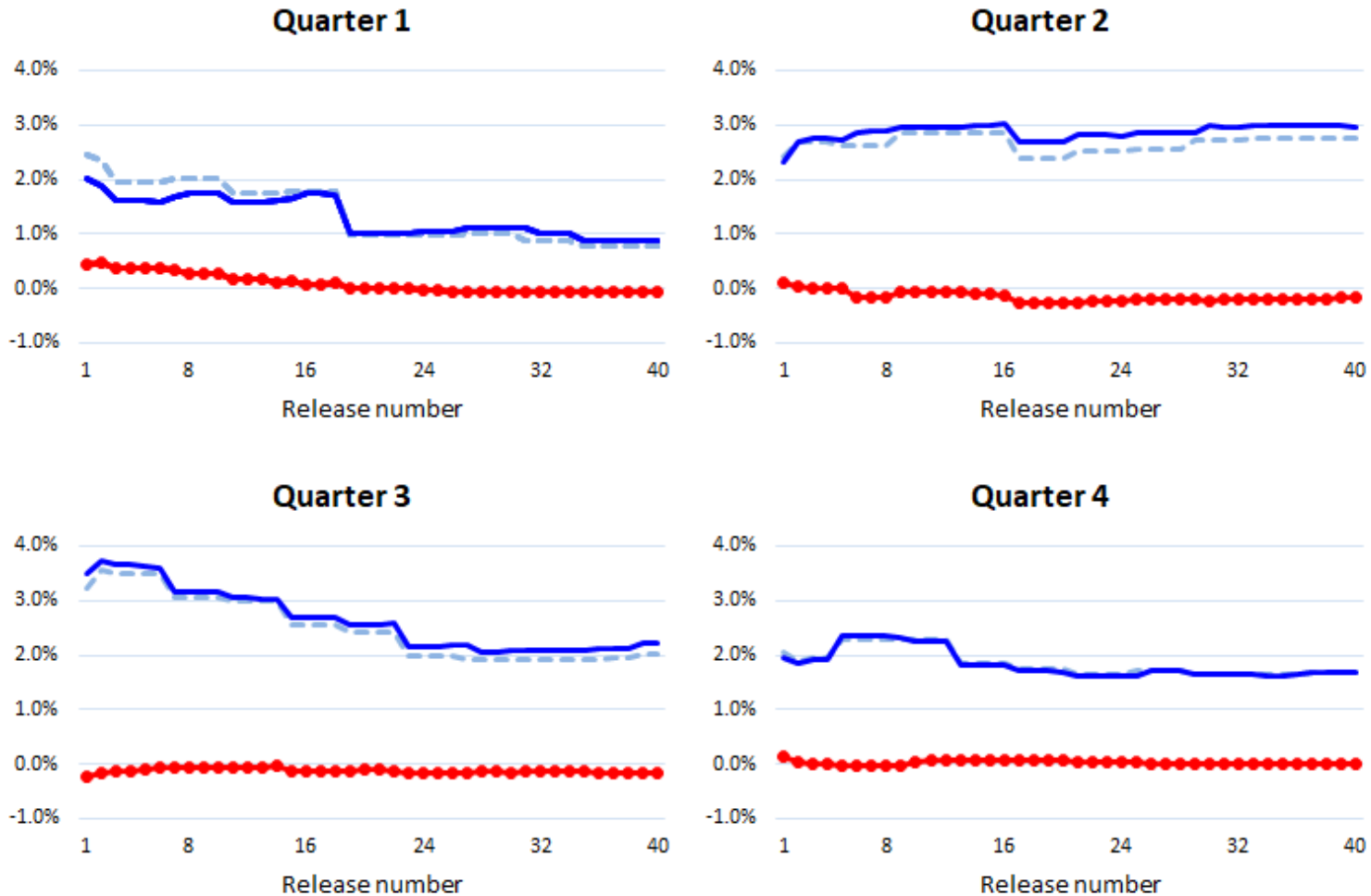
Sample: 2000-2019, excluding 2018Q4 due to government shutdown (For more see Asher et al., 2021)



# Revisions vary by reference quarter

## Average Growth Rate Across Releases

--- Output   ● Hours   — Productivity



# Are revisions predictable?

We test whether R40 values of LP are predicted by early estimates

➤ Regress LP growth estimate as of R40 on LP growth as of:

➤ R0 →  $R^2$  is .38

➤ R2 →  $R^2$  is .49

➤ R2 and R0:  $R^2$  is still .49

➔ So far, not significantly predictable.

# Are magnitudes of revisions predictable?

- Do big revisions predict big revisions?
  - Dependent variable: Absolute values of revisions
  - Regress magnitude of R2-to-R40 revision on R0-to-R2 rev
  - Adjusted- $R^2$  is about .03
  - Coefficient is positive.

Output, labor, and productivity are cointegrated but we don't think their revisions are.



# Outliers in revisions to labor productivity

We show paths of revisions from R0 to R2 to R40 for largest revisions to LP.

## 2008Q4, financial crisis:

- Output revised down from -5.5% to -8.8% to -12.0%
- Hours worked revised from -8.4% to -8.3% to -9.7%
- LP thus revised down from 3.2% to -.6% to -2.6%

## 2015Q1, largest upward revisions to LP:

- Output revised up from -.2% to +.5% to +3.8%
- Hours revised down from 1.7% to 1.6% to .8%
- LP revised up from -1.9% up to -1.1% to +2.9%

# Predictability in special periods

- Do properties of reference quarter predict revisions?
- In preliminary regressions, these predictors are not statistically significant for R2-to-R40 revisions or abs(R2-to-R40 revisions)
  - Recessions
  - 1990s vs 2000s vs 2010s
  - 9/11
  - Election years

# Conclusions so far

- Revisions to output and labor productivity are large until 3-5 years out
- Revisions distributions are not symmetric
- Revisions to output after R2 tend to be negative, especially for Q1
- Distributions of early revisions are not normal, especially for output
  - Underlying distribution of hours-worked growth is peaked, not normal
- Later revisions are not highly predicted by early ones
- We construct prediction intervals based on history, without distribution assumptions
- Ongoing research: effect of comprehensive revisions, other concept/method changes, and other properties of reference periods and release periods

# Contact Information

**Peter B. Meyer**  
Research Economist  
BLS/OPT/DPRPD  
[www.bls.gov/dpr](http://www.bls.gov/dpr)  
202-691-5678  
[Meyer.Peter@bls.gov](mailto:Meyer.Peter@bls.gov)

