Improving the Accuracy of Economic Measurement with Multiple Data Sources: The Case of Payroll Employment Data

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Introduction

How can one combine official and alternative data to improve the accuracy of economic measurement?

Our approach for the case of payroll employment data:

- Build a payroll employment index (ADP-FRB) using alternative, private-source microdata (ADP)
- Compare official and alternative data in benchmarking and forecasting
- Use a state-space model to combine the information in CES and ADP-FRB (treat both as noisy indicators of true employment)

CES, QCEW important in our application: not about replacing government statistics.

Data

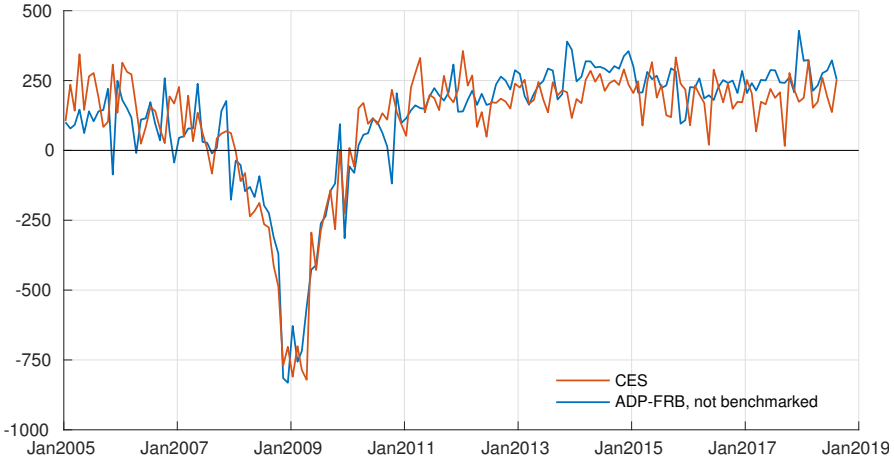
Our data based on records from the payroll processor ADP (July 1999-present):

- ADP processes paychecks for 20 percent of private US workers
- Every pay period: client firm sends ADP data on the number of workers to pay
- We process microdata data into aggregate private employment estimates using methodology analogous to CES

Strengths and weakness of our data:

- We observe all pay periods, not just a reference period
- Not a probability sample, but approximately representative More
- Real-time measurement: we get data updates weekly

CES and ADP-FRB Payroll Employment Gains (in thousands)



ADP-FRB tracks the business cycle very well (even without benchmarking).

Comparing CES and ADP-FRB Payroll Employment Data

CES and ADP-FRB data are annually benchmarked to QCEW data:

- Over the last 10 years, root-mean-squared benchmark revision is 0.49 percent for ADP-FRB data and 0.36 for CES data
- In 4 out of last 10 years ADP-FRB had a smaller benchmark revision, including during the Great Recession Table Great Recession Real-Time Chart
- In annual regressions CES data outperform ADP-FRB data Regression Results

Evaluate the ability of ADP-FRB data to predict the final print of monthly CES data:

- ADP-FRB data are statistically significant for predicting final CES data, even after controlling for market expectations Regression Results
- Improvement in terms of RMSE decline is modest

What is the Best Use of ADP-FRB Data?

Is forecasting the best use of ADP-FRB data?

CES data are subject to measurement imprecision due to:

- sampling error
- birth-death adjustment
- nonresponse
- reference period concept

We proceed by combining the information in CES and ADP-FRB data within a state-space framework.

State Space Model

Kalman filter assumptions:

- Unobserved state (true employment growth) follows an AR(1):

$$\Delta EMP_t^U = \mu(1-\rho) + \rho \Delta EMP_{t-1}^U + \epsilon_t^U$$

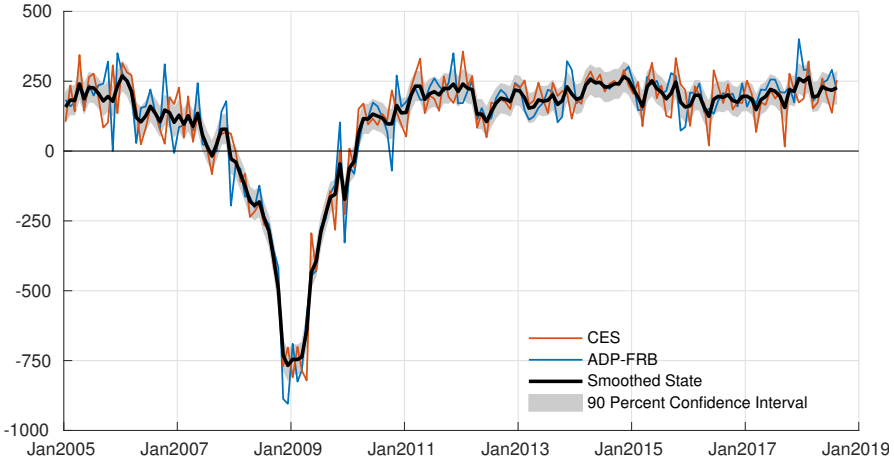
- CES and ADP-FRB are noisy signals of truth:

$$\begin{bmatrix} \Delta EMP_t^{CES} \\ \Delta EMP_t^{ADP\text{-}FRB} \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \end{bmatrix} \Delta EMP_t^U + \begin{bmatrix} \epsilon_t^{CES} \\ \epsilon_t^{ADP\text{-}FRB} \end{bmatrix}$$

Feed in the data:

- Extract estimates of observation noise
- Extract estimates of true employment growth

State Space Estimate of Payroll Employment Gains (in thousands)



State estimate combines the noisy information in both series.

Interpretation of State Space Results

State-space estimates:

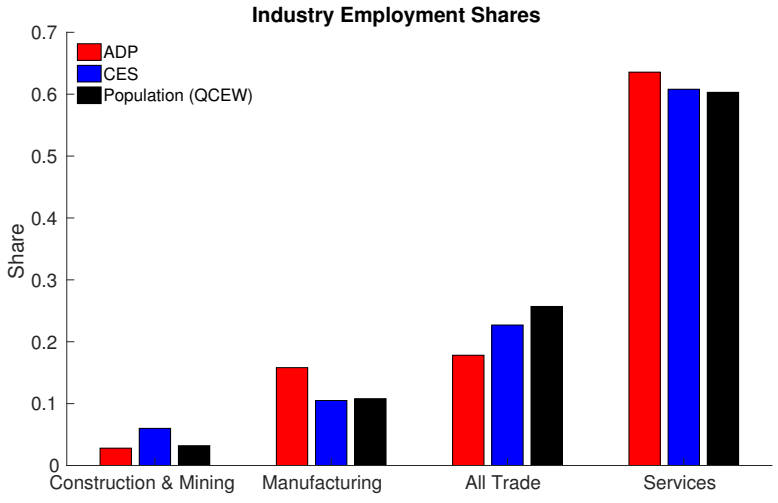
- Model puts roughly equal weight on CES, ADP-FRB (Kalman gains are similar)
- Robust to changes in assumptions: AR(1), random walk, correlation of observation noise
- Adding CPS series, adjusted to match CES scope, yields similar results (very low weight on CPS data)

In a forecasting regression, the state-space estimate outperforms CES and ADP-FRB data (and the state-space estimate based on CES data only). Regression Results

Conclusions

- Alternative data can improve the accuracy of payroll employment estimates
- ADP-FRB data contain similar amount of information as CES data (intuition: roughly similar sample size)
- Statistical agencies could potentially use data from payroll processors to increase their sample size

Representativeness



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Representativeness

Pay frequency	ADP emp.	ADP estabs.	QCEW estabs.
Weekly	23.4	22.4	32.2
Biweekly	55.1	45.8	40.0
Semimonthly	17.5	20.6	18.5
Monthly	4.0	11.2	9.3

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Representativeness

Census Region	ADP emp.	ADP estabs.	QCEW emp.
Northeast	28.2	28.1	18.2
South	29.4	30.2	34.9
Midwest	20.2	16.6	20.1
West	22.2	25.2	26.8

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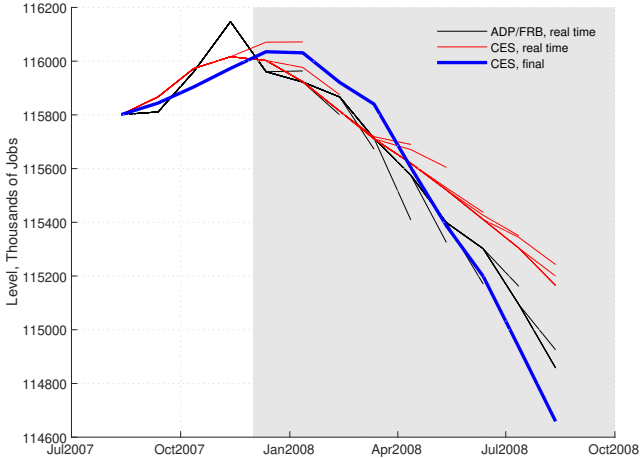
Benchmark Revisions

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
ADP-FRB	-173	-451	12	709	283	-230	-1030	-853	-322	-623
CES	-137	-933	-391	229	481	340	105	-259	-151	136
CES No BD	645	-216	-55	561	972	975	874	638	737	1066

Notes: Units: Thousands of jobs. CES revisions are the post-benchmark (QCEW-based) March estimate less the pre-benchmark estimate. ADP-FRB revisions are calculated in a similar fashion. CES no BD are the CES benchmark revisions that would have occurred excluding net birth-death adjustment. *Source:* `https://www.bls.gov/web/empsit/cesbmart.pdf`, authors' calculations.

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Real-Time vs. Current Vintage Estimates



During Great Recession ADP-FRB data outperformed CES data. Back

Forecasting Annual Employment Changes

	(1)	(2)	(3)	(4)	(5)
CES	1.126***			1.104***	
	(0.0316)			(0.142)	
CES excl. Birth-Death		1.154***			0.927***
		(0.0235)			(0.0847)
ADP			0.976***	0.0197	0.199**
			(0.0543)	(0.121)	(0.0818)
Constant	-163.7*	604.5***	-135.1	-163.6*	452.5***
	(76.93)	(75.29)	(172.8)	(82.61)	(79.37)
Observations	10	10	10	10	10
Adj. R-squared	0.989	0.993	0.965	0.988	0.994
RMSE	299.2	243.3	535.9	319.7	224.2

Notes: Dependent variable is benchmarked annual change in private nonfarm employment, March to March. Years 2008-2017. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. Robust standard errors in parentheses.

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Forecasting Monthly Employment Changes

	(1)	(2)	(3)	(4)	(5)
ADP-FRB active employment			0.29**	0.39***	0.16**
			(0.11)	(0.11)	(0.07)
Lagged private CES employment	0.82***	-0.13	-0.21	0.51***	
	(0.07)	(0.15)	(0.14)	(0.12)	
Lagged UR change	-156.73**	-45.66	-43.05	-123.09**	
	(61.56)	(52.17)	(46.84)	(58.02)	
Unemployment expectations	39.17***	30.95***	14.08	16.55	15.21
	(11.82)	(11.01)	(12.29)	(12.74)	(10.88)
Initial UI claims	-3.10***	-0.91	-0.79	-2.52***	-0.56
	(0.74)	(0.71)	(0.72)	(0.83)	(0.52)
CES employment expectations		1.15***	0.98***		
		(0.16)	(0.15)		
Private CES employment					0.97***
					(0.07)
UR change					33.12
					(36.03)
Constant	4.87	-17.77*	-24.39**	-7.48	-17.85**
	(9.36)	(10.40)	(11.58)	(10.77)	(8.98)
RMSE	99	84	80	92	58

Notes: Dependent variable is final print of CES private employment. ADP series are real-time vintage, as of 5 weeks after the start of the month (i.e., the week before or week of the Employment Situation release). Unemployment expectations are from the Michigan survey. CES employment expectations are eve-of-release median markets expectations. Lagged private CES employment refers to pre-Employment Situation release. Robust standard errors in parentheses. RSMEs are calculated in-sample. * $p<0.10$, ** $p<0.05$, *** $p<0.01$. Estimation period: 2007m1-2018m9.

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Forecasting Monthly Employment Changes with State Estimate

	(1) CES employment	(2) CES employment	(3) 3-month average CES employment
Constant	-28.14	-28.52	-17.05
	(19.43)	(18.78)	(20.35)
ADP-CES State	1.43***	1.50***	1.69***
	(0.49)	(0.55)	(0.44)
ADP-FRB Emp.	-0.18	-0.19	-0.30**
	(0.15)	(0.16)	(0.15)
CES Emp.	-0.18	-0.11	-0.41
	(0.34)	(0.55)	(0.31)
CES State		-0.12	-0.04
		(0.68)	(0.42)

Notes: The dependent variable in columns 1 and 2 is the fully revised change in CES private employment at time $t+1$; in column 3 the dependent variable is the average of the fully revised change in CES private employment for $t+1$, $t+2$ and $t+3$. ADP series are real-time vintage, as of 5 weeks after the start of the month. CES series appearing as independent variable or in state-space estimates are real-time vintage. Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01. Estimation period: 2007m1-2018m9.

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