Payroll Employment at the Weekly Frequency

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The pandemic has demonstrated that timely, high-frequency data can provide critical economic insights in real time (Cajner et al., 2022*a*). The success of nontraditional data has also highlighted the value of traditional products from statistical agencies, given the need to benchmark, validate, and supplement new data sources.

This paper describes our work with real-time, weekly payroll microdata from ADP.[1,2] Payroll employment is one of the most reliable business cycle indicators, so understanding the tenor of the labor market—even a few weeks early—is invaluable. Figure 1 illustrates this point for the early pandemic: As of late April 2020, the March Current Employment Statistics (CES) showed some employment declines, and the April CES report was not yet published. But the more frequent, more timely ADP-FRB series—available through mid-April—already showed the extraordinary pandemic employment losses.

We build off Cajner et al. (2018) and Cajner et al. (2022*b*), estimating weekly measures of active (on payrolls) and paid (receiving a paycheck) payroll employment. The approach entails weekly seasonal adjustment and annual benchmarking. The weekly series provides high-frequency insights while also facilitating easier comparison with monthly BLS payroll concepts than did prior work with ADP data. Additionally, we show how the difference between paid and active employment measures can be used as a proxy for temporary layoffs, an important factor in early pandemic labor markets. Finally, we document how the weekly employment indexes have fared during the pandemic jobs recovery, focusing on the revisions to the CES data for the second half of 2021.

Millions of jobs, change from Feb. 15
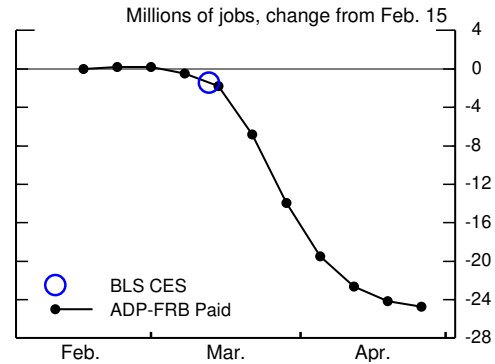
○ BLS CES
● ADP-FRB Paid

FIGURE 1. ADP-FRB AND CES IN SPRING OF 2020

Note: Seasonally adjusted. ADP-FRB values are plotted on their reference days, the Saturdays of each month. CES is plotted on its reference date, March 12.
Source: BLS, ADP LLC, authors' calculations.

I. The ADP-FRB Employment Measure

At the onset of the pandemic the Federal Reserve Board had been working with microdata from the payroll processor ADP for several years. ADP is a provider of payroll services and human resources management solutions; the company processes payrolls for about 20 percent of U.S. workers and is broadly representative in terms of both business (employment) size and industrial sector.

The data we use are compiled weekly and contain information on how many workers were on each client business' payrolls.[3] Importantly, the data record two employment concepts: *paid*, which includes all workers that received a paycheck in a given period, and *active*, which includes all workers that have an ongoing relationship with the business, regardless of whether they were paid.

Businesses pay their workers at various frequencies: biweekly (every 2 weeks) is the most

[3] We assume ADP payroll units are closely akin to establishments (rather than firms), though there is some uncertainty about this.

common, but weekly, semimonthly and monthly pay schedules are also common. Roughly 20 percent of workers are paid (and reported) weekly and 50 percent are paid biweekly, with the remainder being semimonthly or monthly. The data we use derive from the payment events, so the data flow follows the frequency of paychecks. While businesses process payrolls throughout the week, the database of reports we use is updated only at weeks' end, with the reports for the preceeding seven days. Each week some employers pay their workers and the counts are reported in the data. The first estimates of employment growth for a week are based on a subsample of businesses, overrepresenting weekly payers in particular.

For each business we calculate weekly growth rates and remove outliers.[4] Businesses entering or exiting the sample in a given week are dropped, as we cannot be sure if they reflect true business births/deaths or simple ADP client churn. Aggregate growth is the weighted sum of business-level growth, where the weights match the industry and size distribution of the QCEW.[5]

When calculating weekly growth rates, we follow the CES in selecting a reference day. CES asks businesses to report employment for the pay period including the 12th of the month. Analogously, we define employment to be employment for the pay period covering each Saturday. Note that this implies biweekly payers have zero employment growth every other week, as the two Saturdays are within the same pay period. In aggregate this averages out, as biweekly payers are roughly evenly split between even and odd weeks. But it does lead to significant real-time revisions in the raw estimates, as the first estimate of growth for a week only includes one half of the biweekly payers. We adjust the raw real-time estimates using a historical regression of fully revised ADP-FRB growth on the first estimate of ADP-FRB, plus seasonal and holiday indicators. The end result is weekly (non-seasonally adjusted) indexes for both paid and active employment.

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[4]We use the Davis, Haltiwanger and Schuh (1996) (DHS) growth rate that treats positive and negative growth symmetrically. We drop observations where weekly DHS growth is greater than 1.8 or less than -1.8.

[5]Weighted by employment counts for 2-digit NAICS across six size classes. See Cajner et al. (2018).

II. Benchmarking

Two crucial issues for any sample-based statistical indicator of business activity are: i) whether the sample is representative of the entire population; and ii) accounting for changes in economic activity due to business entry and exit. To address these issues retrospectively, statisticians typically resort to benchmarking, since representative population-based comparisons are typically the gold standard for economic statistics. For employment data, the BLS benchmarks the CES March employment level to the March QCEW (and other auxillary sources). This process corrects for the sampling and nonsampling error in the CES March estimates, and the adjustment is smoothly "wedged back" to the preceding March, avoiding discontinuities in the time series. While the benchmarked monthly CES data reflect population data in March, the estimates for other months are a mix of the CES sample-based numbers and the linear wedge.

For the ADP-FRB indexes we follow a similar methodology, with both paid and active employment levels annually benchmarked to match the benchmarked CES level in March. The monthly first differences in ADP-FRB retain the contours of the unbenchmarked ADP-FRB growth rates, with the addition of a linear wedge.[6] In both CES and ADP-FRB, the difference between the revised March employment level and the pre-revision March employment level is the "benchmark miss."

We are mindful that the ADP-FRB sample—while extremely large and broadly representative—may suffer from selection issues that would lead to biased estimates of growth. In addition, our calculations are based on the growth rates of continuing businesses, ignoring employment growth due to business entry and exit. We adjust for slow-moving differences between the raw ADP-FRB estimates and the benchmark data with a "forward correction": an adjustment factor added to ADP-FRB, based on recent benchmark misses. For example, in January of 2022 both the CES and ADP-FRB series were benchmarked to March 2021 QCEW data. Our forward

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[6]The QCEW seasonal patterns are substantially different from both CES and ADP-FRB, and neither we nor the BLS benchmark the monthly data.

correction adds a constant correction factor to each week after March 2021, based on a historical regression of benchmark misses on lagged benchmark misses.[7]   Between 2005 and 2020, the forward correction reduces the root mean squared benchmark miss from 625 thousand jobs to 427 thousand jobs.   Even without the forward correction, ADP-FRB featured a smaller benchmark miss than the CES data in 7 out of the last 15 pre-pandemic benchmark revisions (post-2020 revisions are affected by the switch between active and paid employment; see Section IV).

III.   Seasonal Adjustment

While traditional statistics are most commonly available at monthly or quarterly frequency (with weekly initial claims for unemployment insurance being one important exception), nontraditional data often provide opportunity to measure economic activity at daily or weekly frequencies.   Seasonal adjustment of daily or weekly data can be challenging, particularly when—as is common with nontraditional data—only a few years of data are available.

Prior to the pandemic, our focus was primarily monthly data and we employed Census's X-13 seasonal adjustment program. Monthly averaged growth had strong predictive properties for official employment releases.[8] With the onset of the pandemic, weekly numbers took priority, as the situation was urgent and reference-date timing matters more when there are sharp swings. Seasonal adjustment of weekly data is difficult, because the data are not exactly periodic: the first Saturday of a year can be the first day of the year, the sixth day, or anything in between. Our seasonal procedures for weekly data combine locally weighted regressions on trigonometric functions—which captures the slow-moving periodic component—with a fixed coefficient regression, which account for holidays.[9]   Rather than maintaining and attempting to reconcile separate monthly seasonally adjusted numbers

and weekly seasonally adjusted numbers, we switched to calculating the monthly estimates using the weekly seasonally adjusted data for total private employment and by supersector. Seasonally adjusted weekly series are differenced to estimate the change in employment each week, with a particular focus on BLS reference-week comparisons and four-week moving averages.

The pandemic recession introduced another seasonal adjustment complication: The large swings observed in many economic indicators can distort estimated seasonal factors. In order to address this problem, we decided to stop using data after February 2020 for the estimation of our seasonal factors. The benefit of this procedure is that large employment swings due to the initial and subsequent COVID waves cannot contaminate our seasonal factors. The drawback is that if actual seasonal patterns change over time, our seasonal factors will not be able to account for that.

IV.   Paid Employment, Active Employment, and Temporary Layoffs

Paid employment is conceptually closer to the BLS' CES concept. Unfortunately, in our data paid employment is substantially more volatile than active, due to variation in utilization as well as bonuses, payroll corrections, and other unusual pay events. Additionally, both the active and paid series exhibit different seasonal and trend behavior, active employment performed better in forecasting payroll employment, and the active seasonal patterns more closely mirror those of the QCEW. As a result, we tended to focus on active employment before the pandemic.

Temporary layoffs soared to almost 80 percent of all job losses over the first two months of the pandemic.[10] These layoffs are not well captured by active employment, so we pivoted to focus on paid employment at the start of the pandemic and much of the subsequent employment recovery. Figure 2 shows the evolution of ADP-FRB paid, ADP-FRB active, and CES in the early months of the pandemic. Active employment registered relatively modest losses compared to CES and paid employment, both of which are affected by temporary layoffs.

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[7]This methodology is conceptually similar to the "bias adjustment" methodology used by BLS CES between the 1970s and 2002 (Mullins, 2016).

[8]The use of monthly ADP-FRB numbers based of the average index value of each week entailed rather complex extrapolation adjustments. That is, the need to adjust for the missing weeks of a given month.

[9]See Cleveland and Scott (2007) for details.

[10]Roughly 18 million individuals in April of 2020 according to the CPS.
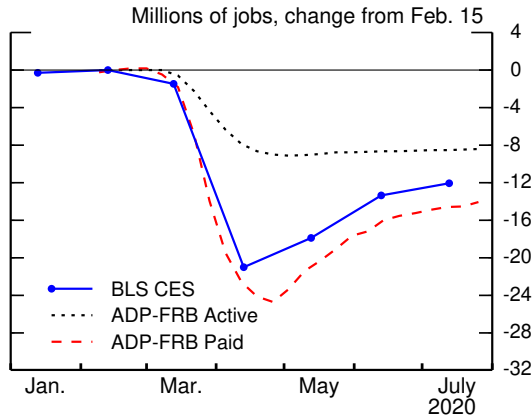
Millions of jobs, change from Feb. 15

FIGURE 2. ADP-FRB AND CES OVER THE PANDEMIC

Note: Seasonally adjusted. CES estimates are monthly, ADP-FRB estimates are weekly.
Source: BLS, ADP LLC, authors' calculations.

In the middle of 2021 employment gains and recalls from temporary employment slowed somewhat. In addition, the share of temporary job losses returned to its pre-pandemic level of about 14 percent in July of 2021. At the same time, the percent of paid and active job losses relative to February of 2020 equalized. These changes motivated our return to focus on active employment for the ADP-FRB employment measure. As a result, we believe a spliced series that combines active employment until March 2020, switches to paid employment through September of 2021, then reverts back to active employment, best captures the high-frequency dynamics of the labor market.

V. The Value of Weekly Employment Indexes

With employment estimates available about nine days after the fact, the ADP data provided critical labor market information during the first month of the pandemic. The same was true at the trough, as weekly ADP-FRB data indicated the start of the recovery in May 2020—suggesting a positive CES employment report for May, contrary to many forecasters (see Figure 2).[11]

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[11]Professional forecasters expected total nonfarm CES employment to drop 7.5 million in May 2020, presumably due to weakness in unemployment insurance claims data. Instead, CES employment rose 2.5 million that month.

In addition to more timely measures of turning points, the weekly data were also able to reflect the impact of subsequent waves of COVID infections, with slowdowns but not outright declines in employment, particularly in the contact-intensive leisure and hospitality sectors, during the delta and omicron COVID waves of 2020 and 2021.

A key benefit of weekly data—as mentioned earlier—is that we do not need to extrapolate from weekly to monthly estimates. That is, once data are in hand for the week containing the 12th of the month, the monthly estimate is available. Moreover, for the weeks following the survey week, it is straightforward to estimate the weekly average of the growth rates following the survey week in order to arrive at the recent tenor of the labor market prior to the next monthly read.

During the pandemic several other nontraditional employment indicators have been used, including those based on data from Homebase, UKG, Dallas Fed Real-Time Population Survey, Census Household Pulse Survey, and Yale Labor Survey. While those indicators have also provided useful information about the labor market, they have generally been less accurate than ADP-FRB data, because these other indicators often have (much) smaller sample size, they are less representative of the national employment, and they also had problems with seasonal adjustment due to short data availability.

VI. Recent Developments and Discussion

While the weekly detail has been less critical during 2022, the ADP data have continued to provide useful information. Figure 3 displays the ADP-FRB series and the first and current readings of the monthly BLS CES data. Two aspects of the figure stand out.

First, there were notable upward revisions to the first CES prints during subsequent releases of the BLS CES data in the second half of 2021. This can be seen in the movement from the hollow grey circles to solid blue dots in Figure 3. These notable revisions changed the tone of the labor market as additional data were released. From August to December 2021, the first print releases of cumulative employment growth was revised up by nearly 1.2 million jobs—a series of revisions that brought the official numbers in
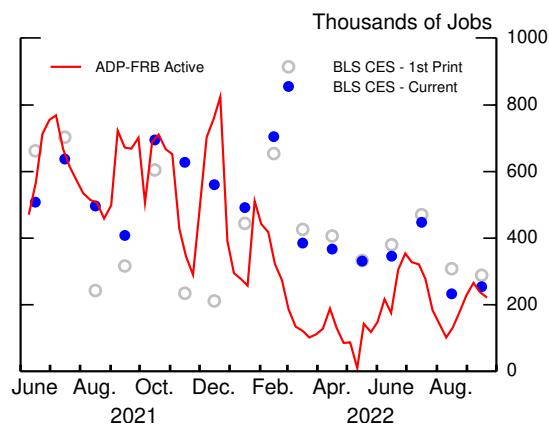
line with the ADP-FRB active estimates.[12]

FIGURE 3. RECENT ADP-FRB DATA AND CES REVISIONS

Note: Seasonally adjusted. Gray circles are the initial CES estimates, blue dots are the current vintage estimates
Source: BLS, ADP LLC, authors' calculations.

Second, there has been another divergence between ADP-FRB and CES data, particularly in the first part of 2022. Indeed, ADP-FRB active employment data show average monthly growth of just over 200,000 jobs per month during January through November 2022, compared with nearly 370,000 jobs per month in the CES data.

The relative weakness of the ADP-FRB series is particularly notable during the second quarter, where the available QCEW data suggest CES overstated private employment growth by a wide margin (Federal Reserve Bank of Philadelphia, 2022). While the reasons for the discrepancies between CES and QCEW are not yet known, possible explanations include potential errors from the CES net establishment birth-death model (which may struggle to accurately forecast given the volatile birth and death patterns of the pandemic) and record-low CES response rates, which have generally hovered around 45 percent this year.[13]

In past work we have argued that both CES and ADP-FRB data provide useful signals about

underlying labor conditions, and we have preferred the use of a Kalman filter estimate combining the two signals (Cajner et al., 2022*b*). This estimate currently suggests average underlying job growth of about 300,000 during 2022 so far. The Kalman filter approach faced challenges in the volatile early pandemic period, but as labor market conditions have normalized it will again be useful.

More broadly, the ADP-FRB data have provided critical insights during the turbulent pandemic period, offering advantages over official data in terms of timeliness and frequency. As noted above, though, the data are most useful when constructed in a manner comparable to official data, with similar benchmarking processes. Combining signals from official and unofficial sources may be a promising approach for other private sector data sources as well.

REFERENCES

Cajner, Tomaz, Laura Feiveson, Christopher Kurz, and Stacey Tevlin. 2022*a*. *Lessons Learned from the U.S. Economic Policy Response to COVID-19.* University of Chicago Press.

Cajner, Tomaz, Leland Crane, Ryan A. Decker,   Adrian   Hamins-Puertolas, Christopher Kurz, and Tyler Radler. 2018. "Using Payroll Processor Microdata to Measure Aggregate Labor Market Activity." Board of Governors of the Federal Reserve System (U.S.) FEDS Working Paper 2020-089.

Cajner, Tomaz, Leland D. Crane, Ryan A. Decker, Adrian Hamins-Puertolas, and Christopher Kurz. 2022*b*. "Improving the Accuracy of Economic Measurement with Multiple Data Sources: The Case of Payroll Employment Data." In *Big Data for 21st Century Economic Statistics*. , ed. Katharine G. Abraham, Ron S. Jarmin, Brian Moyer and Matthew D. Shapiro. University of Chicago Press.

Cajner, Tomaz, Leland D. Crane, Ryan Decker, John Grigsby, Adrian Hamins-Puertolas, Erik Hurst, Christopher Kurz, and Ahu Yildirmaz. 2020. "The US Labor Market during the Beginning of the Pandemic

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[12]The revisions were mostly due to revisions in the concurrent CES seasonal factors, and not the underlying employment data.

[13]Of note, while construction employment has remained remarkably resilient in CES over 2022—despite notable drops in some other construction indicators, such as single-family starts—it fell in QCEW and ADP-FRB data.

Recession." *Brookings Papers on Economic Activity*, 3–34.

Cleveland, William P., and Stuart Scott. 2007. "Seasonal Adjustment of Weekly Time Series with Application to Unemployment Insurance Claims and Steel Production." *Journal of Official Statistics*, 23(2): 209–221.

Davis, Steven J, John C Haltiwanger, and Scott Schuh. 1996. *Job Creation and Destruction.* The MIT Press.

Federal Reserve Bank of Philadelphia. 2022. "Early Benchmark Revisions of State Payroll Employment: 2022 Q2 Vintage." Research Department.

Mullins, John P. 2016. "One Hundred Years of Current Employment Statistics—An Overview of Survey Advancements." *Monthly Labor Review*, August.