“Missing” Workers and “Missing” Jobs Since the Pandemic

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Abstract

Since the start of the pandemic the U.S. labor market has been characterized as being plagued by *missing jobs*, i.e. payroll employment has fallen more than five million jobs short of its pre-pandemic trend, and *missing workers*, i.e. the participation rate has declined by 1.2 percentage points: A pandemic-induced shortage of workers has restrained job creation and, as a result, been a substantial drag on post-pandemic job growth. In this paper, we show that this is a misinterpretation of the data for two reasons. The first is that the number of missing jobs is inflated because it is based on the unrealistic assumption that the pre-pandemic tailwinds for job growth from the decline in the unemployment rate and cyclical upward pressures on participation would have continued in 2020 and beyond if the pandemic would not have occurred. Second, the number of workers missing due to COVID is overstated because the bulk of the 1.2 percentage-point decline in the participation rate since the start of the pandemic reflects a continuation of its long-run downward trend that was already part of projections before the pandemic broke out. Instead, our payroll jobs accounting yields a 810 thousand cyclical shortfall in payroll jobs in October 2022 compared to right before the pandemic. At the recent pace of job growth, even without monetary and fiscal tightening, we expect a substantial deceleration of payroll growth in the coming months.

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1 Introduction

The onset of the COVID-19 pandemic in early 2020 resulted in a deep but brief recession with real GDP decreasing at an annual rate of 32.9 percent in the second quarter of 2020 and the unemployment rate rising from 3.5 percent to 14.7 percent in a matter of weeks. After the drastic drop in economic activity, the economy rebounded briskly. The unemployment rate retreated back to 6 percent by the end of 2020 and reached its pre-pandemic low of 3.5 percent within two years (Figure 1a). Many closely watched indicators of labor market activity such as the job openings rate, wage growth and quits rate reached historically high levels. Despite these signs of strength in the labor market, two important indicators have been pointed to as showing a muted recovery.

The first is the labor force participation rate (LFPR). It has only partially recovered and, in October 2022, is still 1.2 percentage points below its pre-pandemic level (Figure 1b). This apparent shortfall in persons participating in the labor market is often referred to as the *missing workers* after the pandemic. The second is the level of nonfarm payroll employment. As of October 2022, it is 5.8 million jobs short of its pre-pandemic trend (Figure 2). This job deficit reflects the presumed *missing jobs* due to COVID.

Looking at the shortfalls in these two indicators one might infer that COVID has induced a permanent decline in the U.S. labor supply, resulting in a shortage of workers that has hampered job creation and, as a result, dampened nonfarm payroll job growth. In fact, there are several reports that highlight the potential effect of COVID on the size of the U.S. workforce.[1] A simple back-of-the-envelope calculation already reveals a disconnect between the number of missing workers and missing jobs. The U.S. population in August 2022 was 264 million people.[2] So the "missing" workers, reflected in the 1.2 percentage-point decline of the participation rate, are equal to about 3 million persons. That is only about half of the number of "missing" jobs.

A more formal quantitative assessment of the number of missing workers and jobs requires a mapping between nonfarm payroll employment and the labor force participation rate. In this paper we introduce such a mapping, based on a simple accounting identity, and use it to provide an alternative to the missing-jobs-missing-workers narrative. The results we obtain using our accounting method reveal that both the numbers of "missing" workers as well as "missing" jobs are severely overstated.

The vast majority of the 5.8 million "missing" jobs is due to the misguided counterfactual

[1] See, for example, Bach (2022) and Goda and Soltas (2022).

[2] This is the civilian noninstitutional population age 16 and older, which is used as the basis for labor market statistics by the Bureau of Labor Statistics (BLS).

assumption that the labor market recovery that occurred in the five years before the pandemic would have continued at the same pace from 2020 through 2022. If that would have been the case, then if COVID would not have broken out, the unemployment rate would have declined to 2.3 percent in October 2022. A historically unprecedentedly low level and well below the 2019 projections of the 2022 unemployment rate by private sector forecasters and policy makers. These assumed continued cyclical improvements from 2020 through 2022 would have not only pushed up payroll growth through declines in the unemployment rate but also because of continued cyclical upward pressures on the participation rate.

Most of the "missing" workers, that supposedly dropped out of the labor force because of the pandemic, are part of a continuation of the downward long-run trend in participation that was already present before 2020.[3] In fact, relative to that long-run trend we have seen a marked cyclical rebound in participation since the depth of the pandemic. Our measure of the participation cycle, based on Hobijn and Şahin (2021), indicates that the cyclical component of the LFPR in October 2022 was 0.2 percentage points below where it was right before the pandemic.

The accounting identity that we introduce is useful because it allows us to directly link the number of missing jobs, based on the establishment survey (Current Employment Statistics (CES)), to the number of missing workers, taken from the household survey (Current Population Survey (CPS)). It splits the level of payroll employment into five distinct parts. The first captures the difference between the establishment survey (CES), that is the source of the payroll employment data, and the household survey (CPS), that is the source of the unemployment and labor force participation rates. The second captures the difference in scope between payroll employment and household employment. The third term is the employment rate, i.e. one minus the unemployment rate. The fourth is the LFPR. The final one is the size of the population. We use this mapping to link payroll employment growth to changes in the unemployment rate, to changes in the participation rate, and to population growth. The first two terms are related to measurement issues and turn out to be relatively unimportant for the number of missing jobs. So, our main focus is on the last three terms.

Extrapolating the pre-COVID cyclical upward pressures on payroll employment from changes in the unemployment and participation rates reveals that about 4 million of the 5.9 million jobs are due to the unrealistic assumption that these cyclical pressures would have continued from 2020 through 2022 if the pandemic would not have happened. The term "missing" is a misnomer here. They are an accounting fallacy that is the result of comparing apples and oranges

[3] This result echoes the point made be Cooper *et al.* (2021).

in terms of the business cycle.

About a quarter million of the "missing" jobs, i.e. only a twentieth of the total, is due to a slowdown in population growth since the start of the pandemic compared to the five years before. However, it is important to take into account that most of this slowdown was already forecast before the pandemic and, thus, is not fully attributable to the impact of COVID.

About 810 thousand of the "missing" jobs are accounted for by a slightly sharper trend decline in the labor force participation rate since the beginning of 2020 than in the five years before. It is this slightly accelerated trend decline in participation that one could interpret as the source of the "missing" workers. It accounts for less than a third of the 1.2 percentage point decline in the participation rate since the start of the pandemic. Most of the decline is due to the continuation of the long-run trend in participation that was already present before the pandemic.

The remaining, about 810 thousand, "missing" jobs can be traced to the unemployment rate in August 2022 being 0.2 percentage points higher than in February and by a 0.2 percentage point larger drag on the participation rate from its cyclical component in October 2022 than at the onset of the COVID recession. This implies 0.4 percent more cyclical drag on payroll employment in October 2022 than in February 2020, just before the pandemic. Of course, the labor market in 2019 and early 2020 was considered "hot" (Aaronson *et al.*, 2019) and our results suggest that the labor market in the Fall 2022 is reaching approximately the same temperature.[4]

Our analysis suggests that, after the pandemic, the U.S. labor market has rebounded remarkably quickly back to almost where it was relative to its long-run trend. There is little evidence of a structural break in this trend due to COVID. In this sense, there is an important parallel between the discussion about the labor market after COVID and about financial markets and the economy after the Great Recession. Large shocks, like pandemics and financial crises, naturally lead to claims that "This Time Is Different" (Reinhart and Rogoff, 2009). But pandemics have been around even longer than financial crises and things tend to be less different in hindsight than assessed in real-time.

The quick rebound of the labor market back to its long-run trend is a testament to the resilience of the U.S. economy. However, it also means that what is restraining growth in the labor market now is the long-run trend in labor supply, already known before the pandemic,

[4]Several indicators of labor demand and turnover, like job openings and quits, suggest the labor market in the Fall of 2022 is even "hotter" than right before the pandemic. However, it is important to take into account the pace of the recovery that preceeded these two comparison periods. Quits rates and turnover tend to be higher during fast recoveries than slow ones (Hobijn, 2022).

that is not expected to reverse in the coming decade. Combining our accounting identity with the most recent labor-force projections by the BLS, we find that trend payroll job growth is about 65 thousand jobs a month.

This trend estimate implies that, even in the absence of contractionary fiscal and monetary policy, if the recovery in the labor market matures we will see a substantial slowdown in monthly payroll job creation. This observation is important, because it cautions against attributing the likely slowdown in payroll job growth in the Fall of 2022 and Spring of 2023 solely to the impact of policy.

2 From Payroll Jobs and Participation to Missing Jobs and Workers

In this section we introduce a simple, but comprehensive, framework to account for how missing jobs and missing workers are related. In the first subsection we focus on the levels of payroll employment and the participation rate. In the second subsection we compare actual and counterfactual (log) changes in these variables to quantify the number of missing jobs and how it is related to missing workers. In the final two subsections we consider the roles of population growth and the unemployment rate in the number of missing jobs.

2.1 The Link Between Participation and Payroll Employment

Our goal is to analyze both missing workers, reflected in the 1.2 percentage point shortfall of the LFPR relative to the start of the pandemic, and missing jobs, i.e. the shortfall of payroll employment relative to its pre-pandemic trend, in one consistent framework. Comparing these two time series is not trivial because the statistics on payroll employment are from the establishment survey (CES) while those on the participation rate are from the household survey (CPS). These two measures are linked through an accounting identity which we rely on in the rest of this paper to quantify the number of missing workers and jobs in the wake of the pandemic.

To understand the accounting identity that we use, it is important to realize that the BLS publishes two measures of employment. The first one, E_t, is the number of persons who report themselves as *employed* and is based on data from the household survey. The second, J_t, is the number of nonfarm payroll *jobs*, measured as part of the establishment survey. These two employment concepts differ not only because they are constructed from different surveys. They also have a different scope. In particular, J_t measures the number of wage or salary jobs in the nonfarm sector. E_t covers the number of persons employed, on payroll, self-employed, or working unpaid in their family's business, in the whole economy.[5]

We relate J_t, in terms of which we measure missing jobs, to E_t through an identity that isolates the impact of the difference in the survey and the difference in scope. In particular, we write

$$J_t = \underbrace{\left(\frac{J_t}{J_t^H}\right)}_{\substack{\text{Survey}\\ \text{difference}}} \underbrace{\left(\frac{J_t^H}{E_t}\right)}_{\substack{\text{Scope}\\ \text{difference}}} \underbrace{E_t}_{\substack{\text{Household}\\ \text{employment}}} . \tag{1}$$

The above identity separates the survey and scope differences through the use of J_t^H. It is a measure of nonfarm payroll employment constructed using data from the household survey, i.e. the CPS, rather than from the CES.[6] Figure 3 plots the three employment measures from equation (1). Because of the broader scope, the employment level in the CPS, E_t, is higher than the measures of payroll employment, J_t and J_t^H. The payroll employment measures from the CES and CPS are closely aligned since 2015, except for during the pandemic when the household-survey based measure showed more job losses than the establishment survey. Relevant for our analysis, in October 2022 both measures were very close and, thus, measured payroll job growth is not particularly sensitive to what survey it is based on.

Our goal is to map payroll employment into the participation rate. This requires the additional step of expressing household employment, E_t, in terms of the unemployment rate, u_t, the LFPR, $LFPR_t$, and civilian noninstitutional population (CNP), POP_t, i.e.

$$E_t = (1 - u_t)\, LFPR_t\, POP_t, \tag{2}$$

where $(1 - u_t)$ is the fraction of the labor force that is employed, $LFPR_t$ is the fraction of the population that is part of the labor force, and POP_t is the size of the population. Combining Equations (2) and (1) provides the link between payroll employment and the participation rate that we use in the rest of our analysis:

$$J_t = \underbrace{\left(\frac{J_t}{J_t^H}\right)}_{\substack{\text{Survey}\\ \text{difference}}} \underbrace{\left(\frac{J_t^H}{E_t}\right)}_{\substack{\text{Scope}\\ \text{difference}}} \underbrace{(1 - u_t)}_{\substack{\text{Unemployment}\\ \text{rate}}} \underbrace{LFPR_t}_{\substack{\text{Participation}\\ \text{rate}}} \underbrace{POP_t}_{\text{Population}} . \tag{3}$$

[5] In E_t multiple jobholders are counted as one person, while in J_t they are counted as several jobs.

[6] The CPS-based proxy of nonfarm payroll employment we use is "Research series, employment adjusted to CES concepts, seasonally adjusted (LNS16000000)", published by the BLS.

It is useful to write the above equation as additive in terms of log changes, i.e.

$$\underbrace{\Delta \ln J_t}_{\substack{\text{Payroll} \\ \text{growth}}} = \underbrace{\Delta \ln \left(\frac{J_t}{J_t^H} \right)}_{\substack{\text{Change in survey} \\ \text{difference}}} + \underbrace{\Delta \ln \left(\frac{J_t^H}{E_t} \right)}_{\substack{\text{Change in scope} \\ \text{difference}}} + \underbrace{\Delta \ln (1 - u_t)}_{\substack{\text{Unemployment} \\ \text{change}}} + \underbrace{\Delta \ln LFPR_t}_{\substack{\text{Participation} \\ \text{change}}} + \underbrace{\Delta \ln POP_t}_{\substack{\text{Population} \\ \text{growth}}} \tag{4}$$

which implies that payroll employment growth is faster when (i) the unemployment rate declines at a faster rate; (ii) LFPR increases rapidly and (iii) the population growth rate is higher. There is also room for the scope and survey differences to matter, but that, as we show later, these terms turn out to be quantitatively unimportant in the data.

2.2 From Missing Jobs to Missing Workers

The number of missing jobs in Figure 2 is imputed by assuming that average payroll growth from February 2015 through February 2020 would have continued throughout the pandemic and afterwards. In particular, we impute the counterfactual level of payroll employment in month, t, after the start of the pandemic, $\hat{J}_t$, as follows:

$$\ln \hat{J}_t = \ln J_{t^*} + g(J)(t - t^*) \tag{5}$$

Here t^* is February 2020, i.e. the month before the pandemic, $(t - t^*)$ is the number of months since the start of the pandemic, and $g(X_t)$ is the average growth rate of X_t, in this case payroll jobs, during the five years preceding the pandemic. That is,

$$g(X) = \frac{1}{t^* - t_0} (\ln X_{t^*} - \ln X_{t_0}) \tag{6}$$

where t_0 is February 2015. Note that, from equation (4) it follows that

$$g(J) = g\left(\frac{J}{J^H} \right) + g\left(\frac{J^H}{E} \right) + g(1 - u) + g(LFPR) + g(POP) \tag{7}$$

That is, the extrapolated counterfactual trend in payroll growth, that we use to calculate the number of missing workers, is additively separable into parts due to the five drivers of payroll growth. Each of these parts is its extrapolated average growth rate (log change) from the five years before the pandemic.

The number of missing workers is the difference between this counterfactual level of payroll employment in October 2022, which we denote by t_1, and the actual level of payroll employment.

For our analysis, we focus on the log-difference:[7]

$$\ln \hat{J}_{t_1} - \ln J_{t_1} \;=\; \left(\ln \hat{J}_{t_1} - \ln J_{t^*}\right) - \left(\ln J_{t_1} - \ln J_{t^*}\right). \tag{8}$$

Above we have shown that each of the two components on the right-hand side of this equation is the sum of parts due to the five components underlying payroll employment growth. Taking the differences between these respective parts yields that the amount of missing workers is the sum of the shortfalls in each of the five components since the start of COVID from their pre-COVID trends. Mathematically, this yields:

$$\ln \hat{J}_{t_1} - \ln J_{t_1} \;=\; \sum_{X \in \mathcal{X}} g\left(X\right)\left(t_1 - t^*\right) - \left[\ln\left(X_{t_1}\right) - \ln\left(X_{t^*}\right)\right], \tag{9}$$

where

$$\mathcal{X} = \left\{ \frac{J}{J^H}, \frac{J^H}{E}, 1-u, LFPR, POP \right\} \tag{10}$$

Thus, the percentage shortfall in payroll employment from its pre-COVID trend is the sum of the percentage shortfalls of (*i*) the survey difference, (*ii*) the difference in scope, (*iii*) the employment rate, (*iv*) the participation rate, and (*v*) the population level, from their respective pre-COVID trends.

It turns out that the first two terms are relatively unimportant.[8] In the rest of this section we focus on the population and unemployment terms. We then take on the participation term in the next section.

2.3 Population Shortfall in the Wake of COVID

One aspect that might result in a shortfall in the number of jobs is a decline in population growth. This would be captured by post-COVID growth in the CNP coming in below its pre-pandemic trend. The population term in (8) quantifies this. That term yields that the level of the CNP is 0.16 percentage points, about 450 thousand persons, lower in October 2022 than predicted by the pre-COVID trend.[9]

There are three broad reasons for the decline in population growth after the start of the pandemic. The first is longer-run demographic trends, related to declining fertility rates and

[7] We will convert it back to a number of payroll jobs later.

[8] See Figures B.1a and B.1b. They contain the extrapolated trends for the survey and scope differences respectively.

[9] See Figure B.1c for a graphical representation of this result.

immigration. Because of these trends, projections that predate the pandemic already included a decline in the growth rate of the CNP (Dubina *et al.*, 2019). The second is a decline in immigration. The third is the impact of the pandemic on the size of the U.S. population. In fact, National Center for Health Statistics (2022) estimates that the number of excess deaths in the U.S. since the start of the pandemic is 1.2 million. Since COVID disproportionately affects older persons, these excess deaths are mostly in the civilian noninstitutional population.[10] Thus, non-BLS data suggests that the population shortfall might be higher than those on the CNP that we use here.

However, if it were the case that the BLS substantially overestimates the CNP then the household-survey (CPS) based proxy for payroll employment would exceed that based on the establishment survey (CES), which is not the case. As can be seen from Figure 3. Based on that observation, we report the estimate based on the BLS measure of the CNP.

It is important to note that the 450 thousand person gap in the CNP between the pre-COVID trend and the current level of the population does not, one for one, translate into 450 thousand missing jobs. This is because not the whole population is on nonfarm payrolls. Instead, equation (9) reveals that the one-for-one translation is in percentage-point gaps not in the number of persons. Thus, the 0.17 percent lower level of the CNP contributes 0.17 percentage points to the 3.8 percent gap, or one twentieth of the gap, between October 2022 payrolls and the level implied by its pre-COVID trend. That is the equivalent of about 257 thousand payroll jobs.

We conclude that while the slowdown in population growth since the start of the pandemic, compared to the years before, does contribute to the missing jobs phenomenon, it only accounts for a very small part of it.

2.4 The Unemployment Rate and Cyclical Payroll Growth

Equation (4) implies that the contribution of the changes in the unemployment rate, u_t, to the growth in payroll employment is

$$\Delta \ln (1 - u_t) \approx \Delta u_t. \tag{11}$$

An immediate implication of this equation is the rule of thumb that a one percentage point increase in the unemployment rate contributes one percentage point, or about 1.5 million jobs, to payroll growth.

This observation is important, because for the contribution of the unemployment rate to

[10] CNP includes those age 16 and over, but those living in nursing homes are not part of the CNP.

the number of missing jobs we assume that the pre-pandemic trend from 2015 through 2019 would have continued if the pandemic would not have broken out. As can be seen from Figure 1a, the pre-pandemic trend period was one in which the unemployment rate declined by 2.2 percentage points from 5.7 percent to 3.5 percent. The rule of thumb yields that during the 5 years before the pandemic broke out the decline in the unemployment rate pushed up average annual payroll growth by 0.44 percentage points. This is the equivalent of approximately 55 thousand jobs a month.

If this trend would have continued in the absence of the pandemic, then that would imply that the unemployment rate would have had to have declined by a further 1.2 percentage points between February 2020 and October 2022, from 3.5 percent to 2.3 percent. This 2.3 percent would have been a historically low unemployment rate. But, a further decline in the unemployment rate from 2020 through 2022 was not expected by forecasters and policy makers before the pandemic. The mean forecast in the Survey of Professional Forecasters in 2020Q1, right before the pandemic broke out, was for the unemployment rate in 2020 and 2021 to hover between 3.5 and 3.6. The December 2019 Summary of Economic Projections (SEP) shows that the forecasts of FOMC members were very similar to those of forecasters in the private sector.

Ironically, though we experienced the pandemic and the highest unemployment rate in the postwar period in the meantime, the 2019 forecasts of the 2022 unemployment rate were remarkably accurate. This highlights how the period from February 2020 through October 2022 covers a full condensed (labor-market) business cycle. The result is that over the post-COVID period, from February 2020 through October 2022, the contribution of the change in the unemployment rate to payroll job growth is negligible.

Thus, a substantial part of the number of missing jobs reflects those that weren't created because the labor-market recovery from 2015 through 2019 did not continue in 2020 and beyond. These jobs aren't "missing." They are an accounting fallacy that is the result of comparing apples and oranges in terms of the business cycle.

3 Missing Workers and the Participation Cycle

In this section we focus on the term in equation (9) related to the LFPR. That term assumes that the average annual percentage change in the participation rate in the five years preceeding the pandemic would have continued from 2020 through 2022 if COVID would not have hit. During the pre-pandemic period the LFPR increased from 62.7 in February 2015 to 63.4 in February 2020, i.e. by 1.1 percent over five years. From equation (4) we know that percent changes in the LFPR translate one-for-one into percent changes in nonfarm payrolls. This means that the change in participation before the pandemic contributed 0.2 percentage points annually to payroll job growth, which is about 25 thousand jobs a month.

However, this number conflates two very different forces that drive participation. The first is the long-run trend in the LFPR that is driven by demographic trends, in particular in recent years by the aging of the Baby Boom generation, as well as changing participation decisions across cohorts. The second is the cyclical adjustment of the LFPR during the extended labor market recovery period after the Great Recession. To better understand the part of the missing jobs accounted for by the participation rate, it is important to disentangle these two forces. This is because it is reasonable to assume that the long-run trend in participation would have continued after the pandemic broke out, as it was forecast to do. However, just like for the unemployment rate, given the tightness of the labor market right before the pandemic, it would be unrealistic to assume that the cyclical upward pressures on participation would have continued from 2020 through 2022 to the same extent they were present in the pre-pandemic period. A clear distinction of the trends and cycle in the participation rate is also useful to understand to what extent the post-COVID period 1.2 percentage point drop in the LFPR is due to cyclical economic pressures or driven by a longer-run trend.

In the rest of this section, we split changes in the LFPR up into cycle and trend. We show that the cyclical upward pressures on payroll growth from participation in the pre-pandemic period were of the same order of magnitude as those from the decline in the unemployment rate that we discussed in the previous section. Moreover, the cyclical pressures on payroll growth when we compare February 2020 with October 2022 are very small. This is because, just like the unemployment rate, the participation cycle in October 2022 is almost back to where it was right before the pandemic. Our separation of the participation cycle from its trend is based on our earlier work, i.e. Hobijn and Şahin (2021) and Elsby *et al.* (2019).[11]

3.1 Uncertainty About Trend Participation

Cyclical movements in the labor force participation rate are hard to assess due to the non-linear long-run trend in participation. Most studies that try to distinguish between the trend and cyclical components of the participation rate proceed by estimating a trend rate and then treat the deviation of the actual from this trend as the cyclical component (e.g. Aaronson *et al.*, 2006, 2012; Zandweghe, 2012; Aaronson *et al.*, 2014; Hornstein *et al.*, 2018). These studies tend to agree on two stylized facts: (*i*) the aging of the workforce has been reducing the trend participation rate and (*ii*) the labor force participation rate is procyclical. Yet, there is

[11] We explain the intuition of our method in the main text and derive the details in Appendix A.

considerable disagreement about the level of the trend and cyclical components of the LFPR.

This can be seen in Figure 4. It plots the path of the actual LFPR as well as the estimates of the trend participation rates from the aforementioned studies and from the Congressional Budget Office (CBO) and two of the Federal Reserve's Tealbooks. There is a large amount of disagreement about the level of trend participation. For example, the 2015 estimate of trend participation in 2022 by the CBO was 61.4, while the 2022 estimate was 62.6. This 1.4 percentage point difference is the equivalent of about 1.8 million payroll jobs. These differences in trend estimates mainly reflect upward and downward revisions of the whole trend path. There is a broad consensus about the approximate slope of the trend. Almost all the trend estimates in Figure 4 put the slope of the downward long-run participation trend at around 0.25 percentage points a year between 2015 and 2022. This implies a 0.4 percent annual decline in trend participation. Equation (4) yields that this is a 0.4 percentage point drag on payroll growth, which amounts to about 50 thousand payroll jobs a month.

The sudden, more than three percentage point, drop in the LFPR at the onset of the pandemic raised the concern that there was a discontinuity in trend participation. In particular, there is evidence that some persons retired early in the face of the age-biased health risk posed by the pandemic (Faria-e-Castro, 2021). However, recent evidence suggests that these accelerated retirements were later offset by a slowdown in retirements (Thompson, 2022). To what extent these accelerated retirements caused a temporary acceleration in the downward long-run trend participation rate and in how far this acceleration is offset by a subsequent slowdown in retirements is hard to assess.[12]

This is especially true because a large part of the increase in retirements is not because the retirement rate went up but because a smaller share of retirees unretired to take (temporary) jobs (Nie and Yang, 2021). A phenomenon not well understood, since most analyses are based on the assumption that retirement is a permanent state for most retirees. The analysis of flows is not only useful for studying the stock of retired persons, it turns out to be very informative about the dynamics of the labor market as a whole and, in particular, can be used to quantify the main driving forces of the procyclical component of the LFPR.

3.2 Flow-Based Decomposition of Changes in the LFPR

As an alternative to calculating the cyclical component of labor force participation as a the difference between the actual LFPR and an estimated trend, we have proposed to measure the

[12] In addition, the interpretation of the recovery in the LFPR in early 2022 is complicated by a change in the estimated age-composition of the population resulting from the 2020 Census (Robertson and Willis, 2022).

participation cycle based on the part that is driven by the flows that also account for the bulk of the fluctuations in the unemployment rate, namely the job-finding and job-separation rates (Elsby *et al.*, 2019; Hobijn and Şahin, 2021).[13] This measure of the participation cycle has a clear interpretation and can be used to construct a monthly time series of changes in the participation cycle in real time.

Our measure exploits that the joint dynamics of the labor force participation and unemployment rates are driven by the six flows between the labor force states of employment (E), unemployment (U), and nonparticipation (N). It decomposes the evolution of shares of the population in each labor force state, $\{E, U, N\}$, into parts due to changes in each of the six different labor market flow rates between these three states. Of particular interest for our assessment of the number of missing workers, is the sum of the shares of the population that is in E and N, which is the equal to the LFPR. We provide the details of the derivation of the decomposition in Appendix A. Here, we focus on the main intuition behind it and on the resulting measure of the participation cycle.

At each point time, the shares of the population in the labor force states, which we will refer to as stocks, change for two reasons. First of all, even if the flow rates between labor force states did not change, it would take some time for the stocks to settle down at their long-run level implied by these flow rates. This long-run level is often referred to as the *flow steady state*. Secondly, while the stocks are adjusting to this long-run outcome, the flow steady state itself is changing because of changes in the flow rates. Thus, current changes in flow rates move the stocks because they change their long-run values. Past changes in flow rates affect the current trajectory of the stocks because they are still adjusting to previous changes in their long-run outcomes.[14] The result is that current changes in the stocks can be expressed as the sum of parts due to current and past changes in each of the six underlying labor market flow rates. Our decomposition quantifies each of these parts.

The parts of our decomposition are interpretable only in case of relatively small changes in

[13] This builds on the earlier literature that argued for dynamic decompositions to evaluate the role of different margins for unemployment fluctuations. Flow decompositions of the evolution of the unemployment rate, rather than the participation rate, have been used extensively in both the academic literature as well as for real-time analysis of the labor market for policy purposes. Most of these analyses decompose the fluctuations in unemployment into parts due to inflows (separations/job loss) and outflows (job finding). See, for example, Shimer (2005), Fujita and Ramey (2006), Elsby *et al.* (2009), Daly *et al.* (2009), Şahin *et al.* (2021). A smaller number of papers take into account all six labor force status flows, as we do here, for the analysis of the dynamics of unemployment. See Barnichon and Nekarda (2012) and Elsby *et al.* (2015).

[14] Flow decompositions of the unemployment rate often ignore the adjustment dynamics of the stocks to the flow steady state, because they tend to be very fast (e.g. Shimer, 2005; Fujita and Ramey, 2006; Elsby *et al.*, 2009). However, that is not the case for the LFPR and the fact that our decomposition takes them into account is important for the results that follow.

the labor market flow rates. However, during the pandemic the rates at which people exited the labor force spiked and, after that, the entry rates were elevated (Figure 5). This makes our monthly decomposition hard to interpret in the midst of the pandemic. For this reason we, instead, decompose the change in the flow steady state between February 2020 and March 2021 and skip the months in between.[15]

3.3 Entry, Exit, and the Participation Cycle

Though our decomposition tracks the impact of each of the six flows on the LFPR separately, it is clearer to group them into three categories: *entry*, *exit* and the *cycle*. Entry and exit capture the direct effect of labor force entry and exit while the cycle captures how past and present changes in job-finding and job loss—shifts within the labor force—affect the participation rate.

The entry component sums the effect of changes in the rates at which individuals flow into the labor force (either to employment or unemployment) on the LFPR. Everything else equal, an increase in these rates puts upward pressure on the (flow steady-state) LFPR. The exit component captures the effect of changes in the rates at which people leave the labor force, both from employment as well as unemployment. Increases in those rates are a drag on participation.

The *participation cycle* measures how changes in the rates of job-loss, i.e flows from employment to unemployment, and job-finding, i.e. those that flow from unemployment to employment, affect movements in the participation rate. We denote these rates by $P_{E,U}$ and $P_{U,E}$ respectively. These rates capture the flows within the labor force that most studies of participation ignore since they have no *contemporaneous* effect on the LFPR. It might sound puzzling that these flows, that do not involve crossing the participation margin, affect the dynamics of the participation rate.

The reason they do is because the unemployed are much less attached to the labor force than the employed. Specifically, the average share of unemployed that leaves the labor force in a month, $P_{U,N}$, is around 25 percent. That is many times the share of employed that drop out of the labor force, $P_{E,N}$, which averages 2.8 percent. The difference between these two rates is the *attachment wedge*. Because of this large positive attachment wedge, the higher the fraction of the labor force that is unemployed, i.e. the higher the unemployment rate, the more likely participants are to drop out of the labor force in the future. This mechanism, which works through the labor force attachment channel, puts downward pressure on the participation rate

[15] See Hobijn and Şahin (2021) for more extensive discussion of this issue.

going forward when the unemployment rate increases.[16]

Figure 6 plots the cumulative contribution of the entry, exit, and cycle components for each business cycle starting at the trough in the unemployment rate, indicated by the vertical dashed lines. The figure reveals that the cycle component is the only one of the three that puts procyclical pressures on the participation rate.

The exit component is mildly countercyclical. This is because both the average unemployed and employed workers are more attached to the labor force during recessions than during expansions. This decline in the exit rate from participation conditional on (un-)employment in downturns puts *upward* pressure on the participation rate during recessions and in the earlier parts of expansions. The entry component is only mildly cyclical and is most important in driving the long-run non-linear trend in the participation rate.

Note that these components contradict a common explanation of the source of procyclicality of the participation rate, namely that marginal workers exit the labor force during recessions and then rejoin during the tail-end of business cycle expansions (e.g. Summers, 1986; Aaronson *et al.*, 2019). This would mean that the entry and exit margins would put procyclical pressures on participation and our decomposition shows that they don't. Instead, the main source of procyclical pressures on participation is the composition of the labor force in terms of the employed and unemployed, which is mainly driven by the job-finding and job-separation rates. This is what is captured by the participation cycle.

During recessions the unemployment rate increases and, as a result, the composition of participants shifts towards being more likely to subsequently drop out of the labor force. This puts downward pressure on the participation rate. Figure 6 shows that, at their maximum, these pressures push the participation rate down by more than a percentage point for all recessions in our sample (except for the one that started in 1980). The largest drag on the LFPR from the participation cycle was during the Great Recession, when it depressed the participation rate by more than three percentage points.

Note that over the prepandemic period from February 2015 through February 2020, the participation cycle provided a two percentage point boost to the LFPR. This amounts to a 3 percent cyclical increase in the participation rate due to the improvement in labor market conditions between the beginning and the end of the period. Applying equation (4) we obtain that this 3 percent increase contributed 0.6 percentage points to annual payroll growth over the prepandemic period. That is the equivalent of about 75 thousand payroll jobs a month created over that period. Thus, over the five years before the pandemic, the cyclical recovery

[16] See Appendix A for a formal discussion of the attachment wedge.

in the participation rate was an important factor underlying the growth in payrolls. These positive cyclical pressures from participation are driven by the same two flow rates that drive improvements in the unemployment rate. The unemployment rate was forecast to flatten out from 2020 to 2022 before the pandemic. If these forecasts were correct then cyclical upward pressures on participation would also have dissipated from 2020 through 2022 if the pandemic did not happen.

These upward cyclical pressures on participation during the five years before the pandemic stand in stark contrast to those after the start of the pandemic. Figure 6 reveals that the participation cycle in October 2022 is 0.2 percentage points below its level in February 2020. But 0.2 percentage points on the participation rate amount to 0.3 percent. Therefore, equation (4) shows that this means that 0.3 percentage points of the 5.3 percent shortfall in payroll jobs relative to their prepandemic trend, or about 480 thousand payroll jobs, can be attributed to the participation cycle in October 2022 being below its level at the start of the pandemic.

It is also useful to consider what this implies for the number of missing workers. Since the start of the pandemic, between February 2020 and October 2022, the LFPR has declined by 1.2 percentage point. That amounts to about 3.0 million persons. Our estimate indicates that, of this 1.2 percentage point, 0.2 percentage points, or about 530 thousand persons, are due to the participation cycle in February 2020 being stronger than in October 2022. The remaining 1 percentage point is driven by longer-run forces related to changes in entry and exit rates.

This 1 percentage point is higher than the 0.6 percentage point decline implied pre-COVID long-run trend consistent with our estimate of the participation cycle. The pre-COVID long run trend implied by our participation cycle estimate is of the same order of magnitude as the 0.25 percentage point annual decline in the LFPR from the trend estimates in Figure 4.[17]

Translating percentage points into persons yields that about 2.4 million of the 3.0 million "missing" workers can be traced to a long-run trend decline in participation. Most of this decline, i.e. about 1.5 million persons, that was already penciled in before the surprise of the pandemic. This result confirms the point made by Cooper *et al.* (2021), who emphasized that a comparison of post-COVID levels of the participation rate with pre-COVID levels are not useful because it ignores this long-run trend.[18]

Based on our analysis of the participation cycle, we find that the 1.2 percentage point decline in the participation rate since the start of the pandemic is largely in line with a continuation

[17]Two and a half years of 0.25 percentage points annual declines adds up to 0.625 percentage points.

[18]It is important to be careful to not to put too much weight on month-to-month changes in the LFPR. The LFPR is highly seasonal and noise in the seasonal adjustment can contribute to these changes. Remember that a 0.1 percentage point change in the LFPR is the equivalent of about 250 thousand nonfarm payroll jobs.

of the long-run downward trend in participation at a rate that was estimated before 2020 and with a normal cyclical response of the participation rate to the deterioration and subsequent improvements in labor market conditions. In short, we find little evidence of a substantial number of "missing" workers who are part of an unusual decline in the labor supply since the onset of COVID.

4 The Number of "Missing" Jobs Dissected

So, if there is little evidence of an unusual decline in the labor supply since the onset of the pandemic, then what is driving the shortfall of payroll jobs relative to their pre-pandemic trend? We now have all the parts of equation (9) to answer this question. The answer is provided in Table 1.

The first column of the table shows the percentage point contribution of each of the parts to the percentage point change in payroll employment since the onset of the pandemic that would have occurred if the pre-pandemic trend would have continued. For example, if the upward pressures of the participation cycle on payroll growth from February 2015 through February 2020 would have continued for another two years and eight months, that would have contributed 1.6 percentage points to the 4.2 percent total counterfactual increase in payrolls. Of course, as we have argued above, the assumption that the tailwinds from the cyclical participation pressures would have continued if COVID would not have happened contradicts the 2019 projections of professional forecasters and members of the FOMC and would have required the unemployment rate to decline to historically unprecedentedly low levels. In fact, more than half of the 4.2 percent counterfactual growth in payrolls since February 2020, 2.7 percentage points to be precise, is driven by the unrealistic assumption of the continuation of the pre-pandemic cyclical upward pressures on payroll employment from the unemployment and participation rates.

The second column of Table 1 lists the actual percentage point contribution to payroll growth over the post-pandemic period. For example, the long-run negative trend in the participation rate was a 1.5 percentage point drag on payroll growth from February 2020 through October 2022. Population growth, even though it slowed since the start of 2020, still contributed 1.9 percentage points to payroll growth. The two cyclical components, i.e. the unemployment rate and the participation cycle, together reduced payroll growth by 0.5 percentage points.

The third column takes the difference between the first two and measures the percentage point contribution to the 3.7 percent shortfall in payroll jobs in October 2022 compared to their pre-pandemic trend. Notice that the bulk of the 3.7 percent is due to the unemployment rate and the participation cycle. However, this is not because there is a large cyclical shortfall in the unemployment and participation rates in October 2022 compared to February 2020. Instead, it is because of the unrealistic assumption that the pre-pandemic cyclical recovery would have continued after 2020 if COVID would not have happened. Notice that the survey and scope differences together account for only -0.2 percentage points of the 3.7 percent shortfall. Changes in the long-run trend in the participation rate and the rate of population growth since the onset of COVID only account for a bit more than a tenth of the shortfall.

The last three columns of the table translate the first three columns to payroll jobs in October 2022. So, if the unemployment rate would have continued to decline after the pandemic broke out at the same pace it declined in the five years before that would have generated 1.8 million payroll jobs. Similarly, under this unreasonable assumption, a continued recovery in the participation cycle would have generated another 2.5 million payroll jobs. Thus, the majority of the “missing” jobs is attributable to the misguided comparison of different stages of the business cycle. We do not consider these jobs as “missing.” Instead, they are the result of an unreasonably constructed counterfactual.

In reality, the unemployment rate in October 2022 was 0.2 percentage points higher than in February 2020. That is the equivalent of 333 thousand payroll jobs. Our assessment that the participation cycle in October 2022 had not fully recovered to its February 2020 level accounts for 480 thousand of the “missing” jobs. Thus, the shortfall in cyclical labor-market forces in October 2022 compared to right before the pandemic is about 810 thousand payroll jobs. A reasonable assumption, and the one made by forecasters and policy makers in 2019, would be that, if COVID would not have occurred, the mature labor-market recovery after the Great Recession would have resulted in no further cyclical adjustments in the unemployment and participation rates after 2020. Under that assumption, the actual drag of 810 thousand jobs from the unemployment rate and participation cycles would be the estimate of the cyclical jobs shortfall in October 2022 compared to February 2020.

One might be surprised by our estimate that cyclical slack in the labor market in October 2022 slightly exceeds that in February 2022, given the elevated levels of quits and job openings. However, it is important to bear in mind that, because of the high speed of the recovery after the COVID recession, payroll job growth is still higher than at the start of 2020. Historically, and consistent with common models of on-the-job search, quits and job openings have been more elevated during fast recoveries (Hobijn, 2022).

The last column of the table calculates the net contribution of each of the six components of payroll growth to the 5.8 million “missing” jobs. The entry for the LFPR trend in this column, which is 810 thousand jobs, can be interpreted as an estimate of of the impact of the number of missing workers due to a change in the trend labor supply after the pandemic.[19] The labor supply is further restrained by a decline in the population growth rate since the pandemic. Together the labor-supply impact of changes in trend LFPR and population growth since the onset of the pandemic amounts to about 1.1 million payroll jobs in October 2022.

5 Implications for Payroll Job Growth Going Forward

In Table 1 we found that the difference in the labor market cycle between February 2020 and October 2022, in terms of the unemployment and participation rates, is the equivalent of about 810 thousand payroll jobs. This is mainly due to the participation cycle in October 2022 holding the LFPR back by 0.2 percentage points compared to February 2022. These 0.2 percentage points on the participation rate translate 0.3 percentage points on nonfarm payrolls, or about 480 thousand jobs.

It is useful to consider how quickly this 810 thousand cyclical deficit in the number of payroll jobs since the onset of the pandemic might be made up. In the three months ending in October 2022 the average monthly change in nonfarm payrolls was 290 thousand jobs. Based on this, it might be tempting to infer that the cyclical deficit will be erased in three months time. But that is not necessarily the case, because part of payroll job growth reflects its long-run trend rather than its cyclical adjustment.

Equation 4 provides a very intuitive way to think about trend payroll growth. If we assume that, when on trend, the changes in the survey and scope differences as well as in the unemployment rate and participation cycle are negligible then trend payroll growth is equal to the long-run trend growth rate of the participation rate plus the population growth rate. This is the growth rate of the size of the labor force.[20]

The most recent labor-force projections by the BLS estimate the labor force to grow at 0.5 percent a year from 2021 through 2031; The rounded difference of 0.7 percent population growth minus 0.3 percent growth of the LFPR.[21] If correct, this would imply a level of trend nonfarm job growth of 65 thousand jobs a month. There is some downside risk to this estimate, because the BLS' estimate of the trend decline in participation is lower than the estimates we plotted in Figure 4. An increase in immigration could potentially push up this trend job growth.

[19] Note that part of this break was already incorporated in labor forceprojections before 2020 and, thus, this is an overestimate of the impact of COVID.

[20] Note that this differs from the calculation of the Atlanta Fed's Job Calculator that considers a target LFPR rather than a long-run negative trend in participation.

[21] Employment Projections — 2021-2031, released on September 8th 2022.

The main point here is that trend payroll growth is low and that the bulk of the recent strong payroll job growth numbers reflects a continued cyclical improvement in the labor market. If payroll jobs continue to increase at a pace of 290 jobs a month for the next few months, the labor market cycle will have caught up with its level in February 2020, right before COVID broke out, in early Spring 2023. Even in the absence of any policy measures, like the recent Fed Funds increases by the Federal Reserve, the labor market cycle will reach a stage of maturity that leaves little room for payroll growth to exceed its trend level. Thus, even without monetary and fiscal tightening, we should expect a substantial slowdown in payroll growth. This observation is important because it cautions against attributing the slowdown in payroll growth solely to the impact of policy. Of course, our calculation of trend payroll growth assumes the unemployment rate will stabilize at around 3.7 percent. So, a better gauge of the impact of policy would be changes in the unemployment rate and the, related, movements in the participation cycle.

6 Conclusion

Two observations about the macroeconomic performance of the U.S. labor market might seem to suggest that there has been an abrupt change in the long-run dynamics since the onset of the pandemic in March 2020. The first is that there are "missing" workers who have dropped out of the labor force when COVID broke out and have not returned since, resulting in a one percentage point drop in the LFPR since the start of the pandemic. The second is that there are millions of "missing" jobs. Payroll employment in October 2022 is more than 5.5 million jobs below its pre-pandemic trend. The combination of these two observations might lead one to conclude that a drop in the U.S. labor supply related to COVID has been a restraining force on job creation that has resulted in millions of jobs not being created because of a lack of workers.

In this paper we dispelled this narrative by using a simple accounting identity to relate the millions of "missing" jobs to the pre- and post-pandemic changes in the unemployment and participation rates as well as to population growth. This accounting identity allows us to combine published macroeconomic time series on labor market aggregates with our estimate of the cyclical pressures on labor force participation (Hobijn and Şahin, 2021) to split up the "missing" payroll jobs into several clearly interpretable parts.

The bulk of the more than five million "missing" jobs is due to the misguided counterfactual assumption that the labor market recovery that occurred in the five years before the pandemic would have continued at the same pace from 2020 through 2022. If that would have been the case, then if COVID would not have broken out, the unemployment rate would have declined to 2.3 percent in the Fall of 2022. A historically unprecedentedly low level and well below the 2019 projections of the 2022 unemployment rate by private sector forecasters and policy makers. These assumed continued cyclical improvements from 2020 through 2022 would have not only pushed up payroll growth through declines in the unemployment rate but also because of continued upward cyclical pressures on the participation rate.

About a quarter million of the "missing" jobs, i.e. only a twentieth of the total, is due to a slowdown in population growth since the start of the pandemic compared to the five years before. However, it is important to take into account that most of this slowdown was already forecast before the pandemic and, thus, is not fully attributable to the impact of COVID.

About 810 thousand of the "missing" jobs are accounted for by a sharper trend decline in the labor force participation rate since the beginning of 2020 than in the five years before. It is this accelerated trend decline in participation that one could interpret as the source of the "missing" workers. It accounts for less about a third of the 1.2 percentage point decline in the participation rate since the start of the pandemic. Most of the decline in the participation rate is a continuation of the downward long-run trend in participation that was already present before 2020 (Cooper *et al.*, 2021) and part of the acceleration of the trend was already forecast before the pandemic.

The remaining, about 810 thousand, "missing" jobs can be traced to the unemployment rate in October 2022 being 0.2 percentage points higher than in February and by a 0.2 percentage point larger drag on the participation rate from its cyclical component in October 2022 than at the onset of the COVID recession.

Our accounting exercise in this paper is a 30,000 ft analysis of labor market aggregates. Because of that, it misses many underlying effects of the pandemic. COVID has had a major impact on our health and psyche and many of us have been affected through the loss of family and friends. This paper is by no means intended to brush off the emotional and economic pain the pandemic has caused.

What our results show is that, after the introduction of the vaccines in early 2021, the U.S. labor market has recovered very quickly to almost where it was, relative to its long-run trend, at the beginning of 2020. This is a good sign for the resilience of the labor market. However, it also means that what is restraining growth in the labor market now is the long-run trend in labor supply, already known before the pandemic, that is not expected to reverse in the coming decade.

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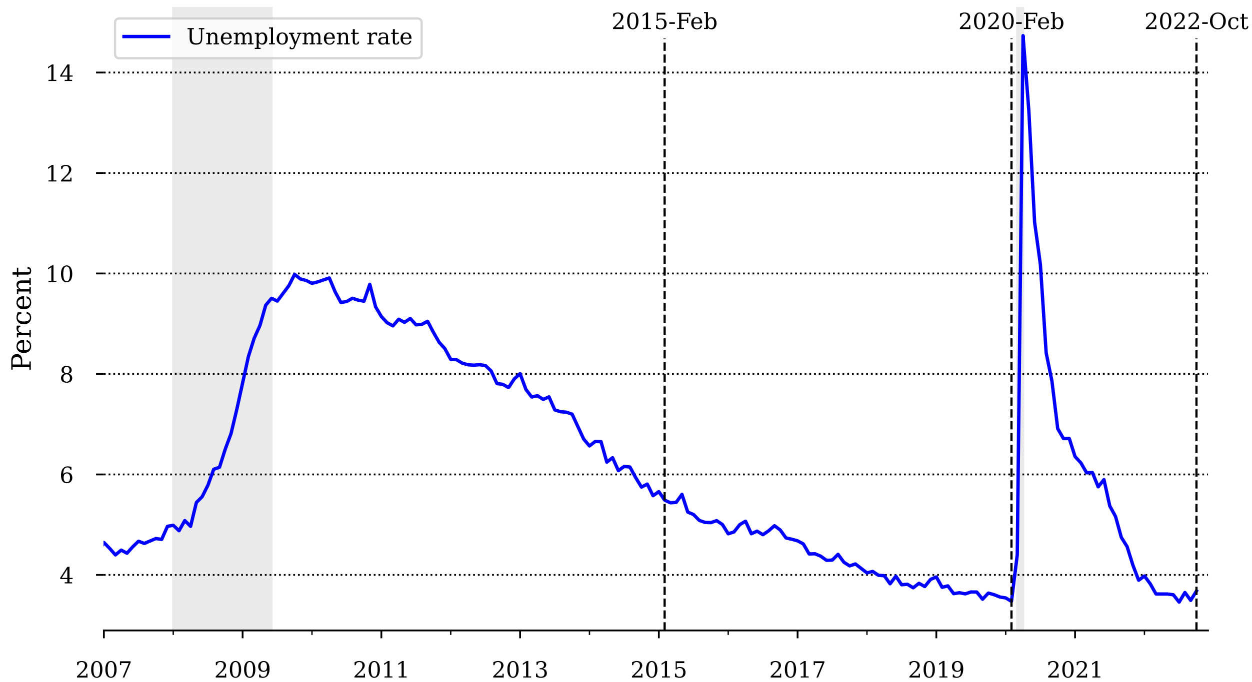
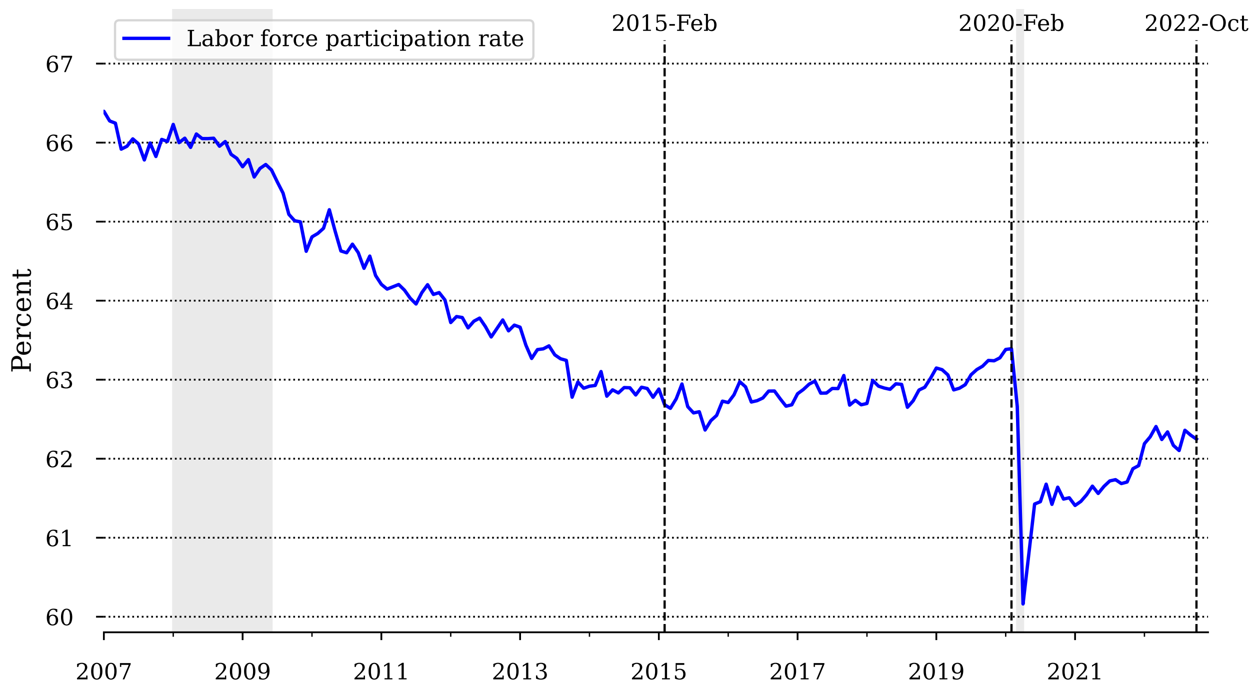


(a) Unemployment rate



(b) LFPR

Figure 1: Unemployment and labor force participation rates

Source: BLS.

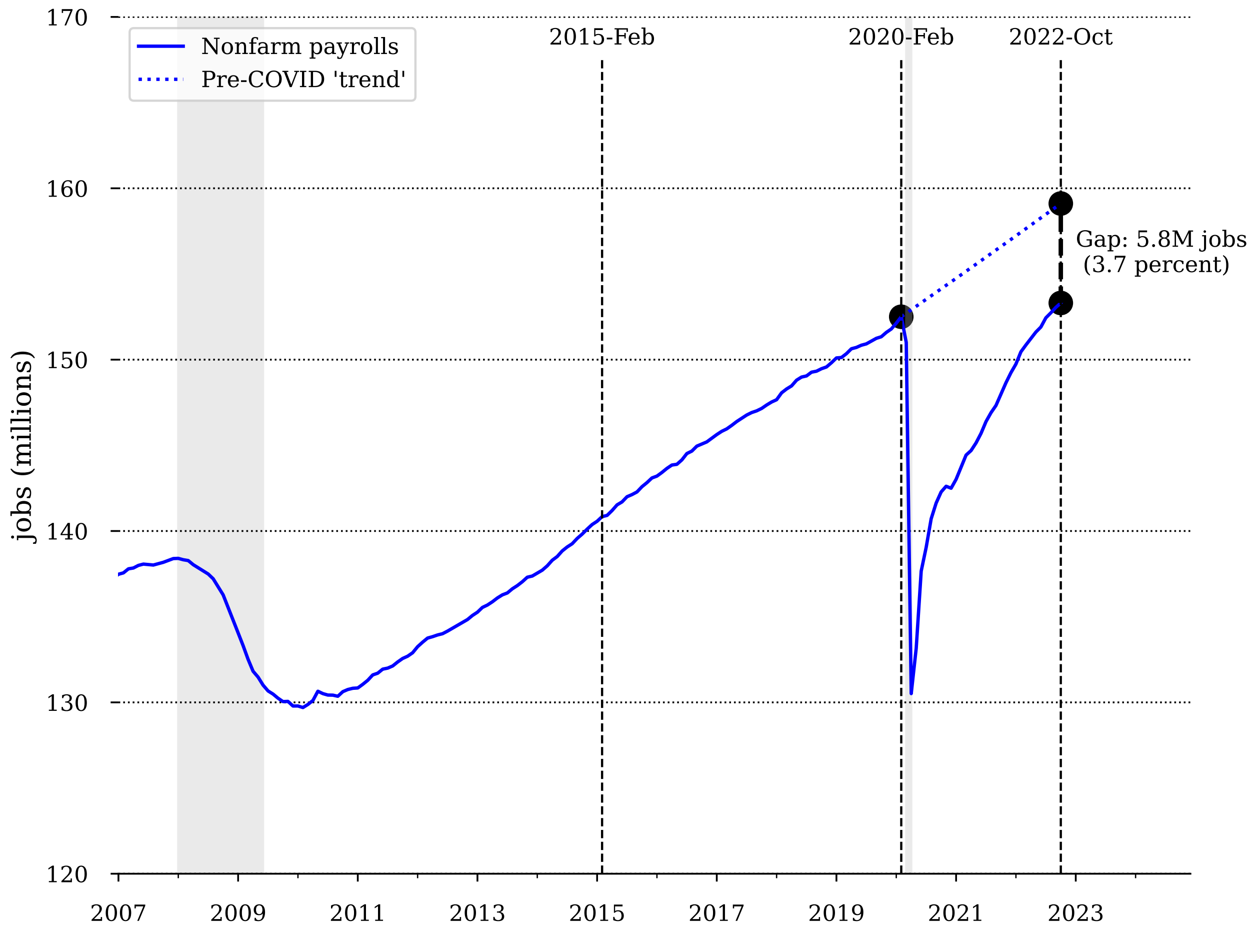


Figure 2: Post-COVID Payroll Gap

Source: BLS and author’s calculations.
Note: Post-COVID ‘trend’ is based on average growth (log change) in nonfarm payroll employment growth between February 2015 and February 2020.

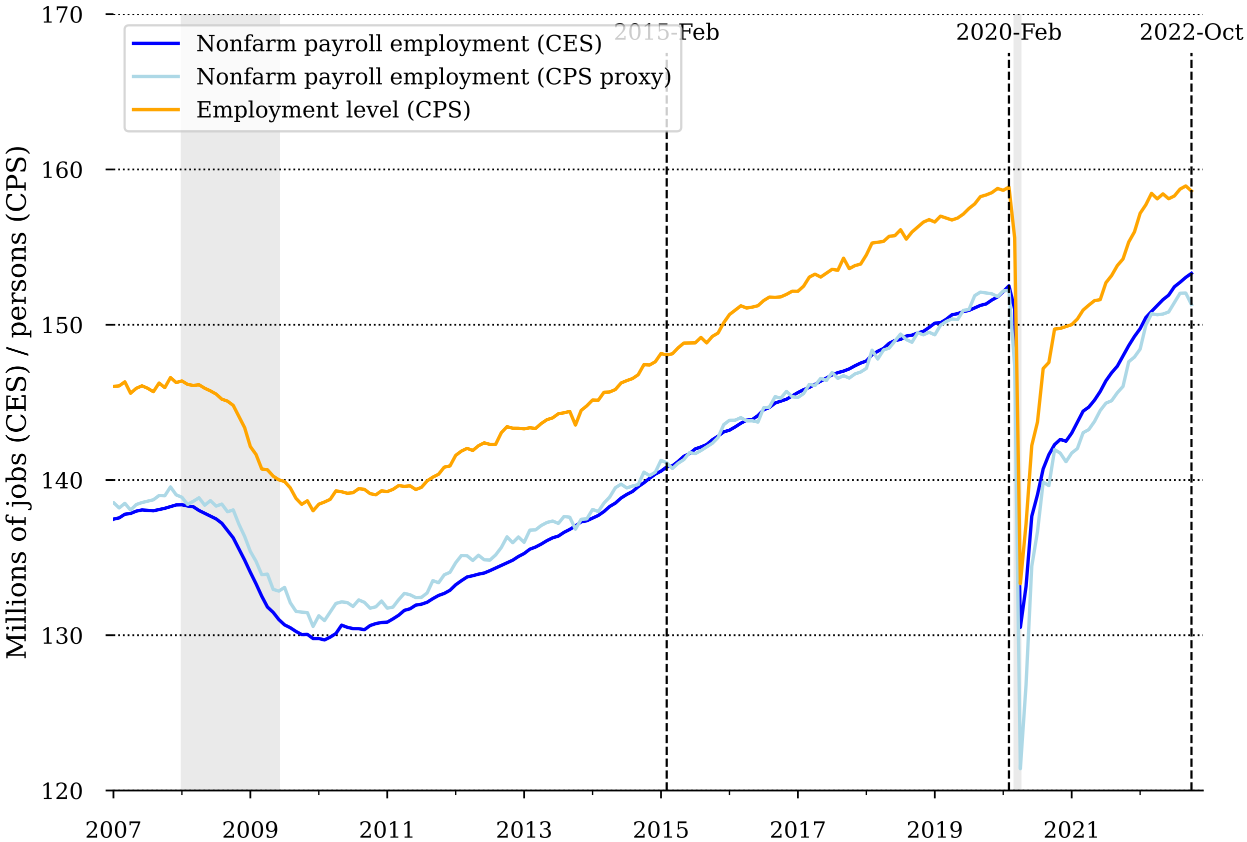


Figure 3: Three employment measures from household and establishment surveys

Source: BLS
Note: CPS proxy for nonfarm payroll employment is "Research series, employment adjusted to CES concepts, seasonally adjusted" by the BLS.

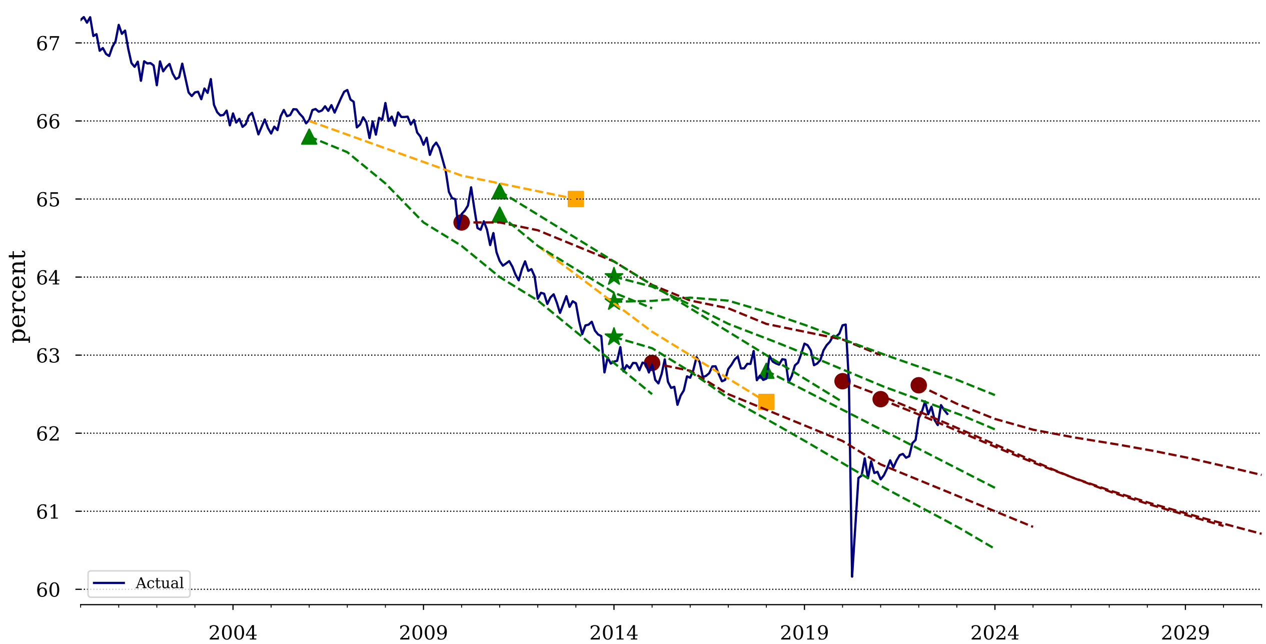


Figure 4: Actual LFPR and various trend estimates

Source: BLS and authors’ calculations.
Note: Actual is seasonally adjusted monthly observations. Trend estimates by source: ●: CBO trend estimates (2011,2015,2020,2021), ■: Tealbook estimates (backward-looking, Jan 2011 and Jan 2015) and ▲: from Aaronson *et al.* (2006), Aaronson *et al.* (2012), Zandweghe (2012), Aaronson *et al.* (2014), and Hornstein *et al.* (2018).

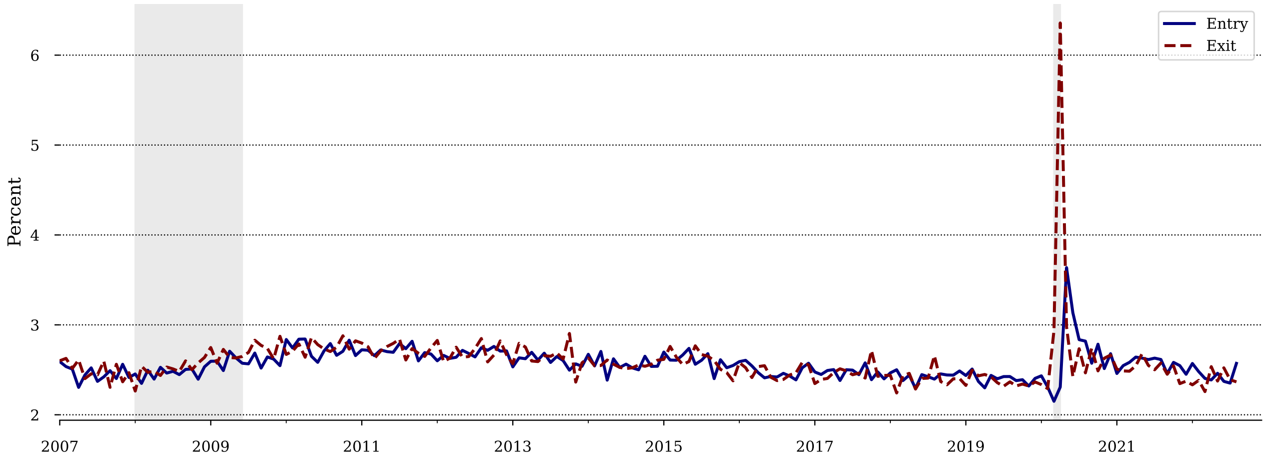


Figure 5: Labor force entry and exit rates as a fraction of the labor force.

Source: BLS.
Note: Seasonally adjusted monthly data.

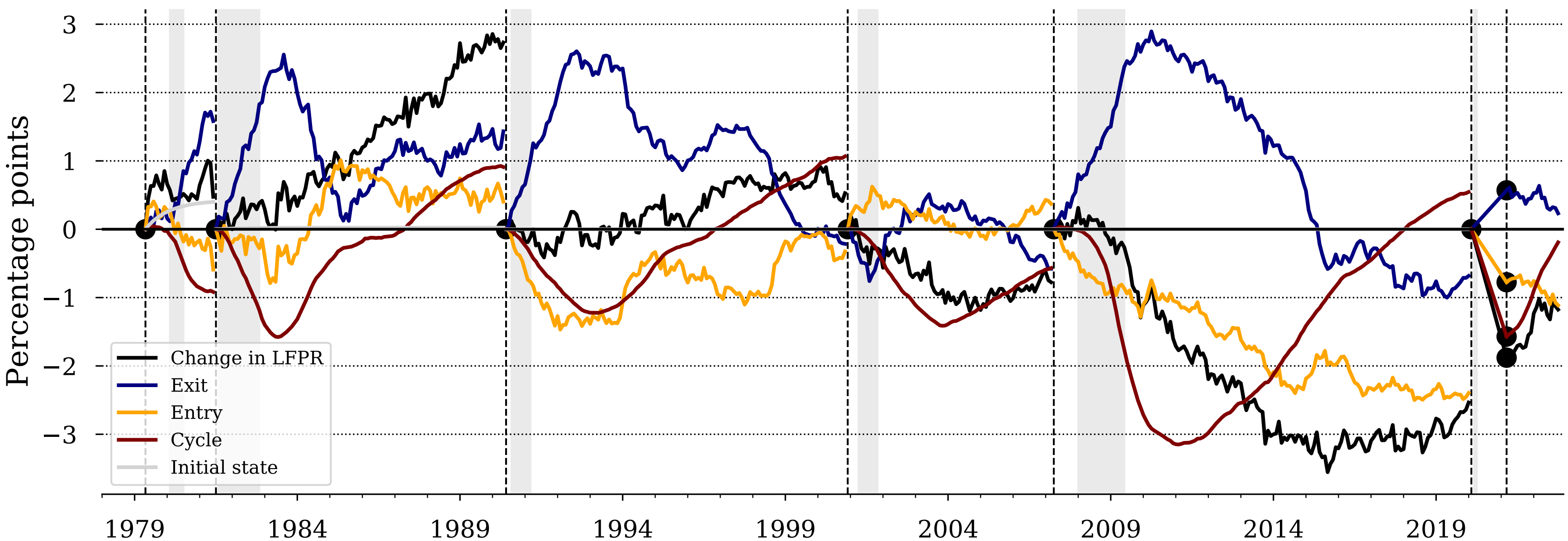


Figure 6: Change in LFPR since January 1978 decomposed, 1978-2022

Source: BLS and author's calculations. Update of Elsby *et al.* (2019).
Note: Seasonally adjusted monthly data. Cumulative effect on employment-to-population (EPOP) since January 1978. Entry is contribution from $P_{N,U}$ and $P_{N,E}$, exit is contribution from $P_{U,N}$ and $P_{E,N}$, and cycle from flows between U and E, i.e. $P_{E,U}$ and $P_{U,E}$. For 2020-Feb through 2022-Mar the decomposition is based on the change in the flow steady-state participation rate due to large changes in transition probabilities that make the results of the month-to-month decomposition uninterpretable.

Table 1: Number of missing jobs dissected

	Percentage points			Jobs		
	Counterfactual	Actual	Difference	Counterfactual	Actual	Difference
Unemployment rate	1.1	-0.2	1.3	1757	-333	2090
LFPR - cycle	1.6	-0.3	1.9	2489	-481	2969
LFPR - trend	-1.0	-1.5	0.5	-1553	-2362	810
Population growth	2.0	1.9	0.2	3179	2922	257
Survey difference	0.2	1.1	-0.9	314	1764	-1449
Scope difference	0.3	-0.4	0.7	437	-689	1127
Total	4.2	0.5	3.7	6624	821	5803

Source: BLS and authors' calculations.
Notes: Percentage points are log changes multiplied by 1000. Last three columns reported in thousands of nonfarm payroll jobs.

A Mathematical details

A.1 Six-Flow Decomposition of the Participation Rate

The state of the labor market can be summarized by two shares, the share of the population that is employed in month t, which we denote by E_t, and the share that is unemployed, U_t. The share of nonparticipants, N_t, is simply implied by the constraint that the three shares add up to one. The transition probabilities determine the evolution of these shares according to the following two equations[22]

$$E_t = (1 - P_{E,U,t} - P_{E,N,t})\, E_{t-1} + P_{U,E,t} U_{t-1} + P_{N,E,t} (1 - E_{t-1} - U_{t-1}), \text{ and} \tag{12}$$

$$U_t = (1 - P_{U,E,t} - P_{U,N,t})\, U_{t-1} + P_{E,U,t} E_{t-1} + P_{N,U,t} (1 - E_{t-1} - U_{t-1}). \tag{13}$$

For the purpose of our decomposition it is easier to write these equations in matrix form. The state of the labor is represented by the vector

$$\boldsymbol{s}_t = \begin{bmatrix} E_t & U_t \end{bmatrix}'. \tag{14}$$

Given this definition, equations (12)-(13) can be written as

$$\Delta \boldsymbol{s}_t = \boldsymbol{s}_t - \boldsymbol{s}_{t-1} = \boldsymbol{d}_t + \boldsymbol{P}_t \boldsymbol{s}_{t-1}, \tag{15}$$

where

$$\boldsymbol{d}_t = \begin{bmatrix} P_{N,E,t} \\ P_{N,U,t} \end{bmatrix}, \text{ and } \boldsymbol{P}_t = \begin{bmatrix} -P_{E,N,t} - P_{E,U,t} - P_{N,E,t} & P_{U,E,t} - P_{N,E,t} \\ P_{E,U,t} - P_{N,U,t} & -P_{U,E,t} - P_{U,N,t} - P_{N,U,t} \end{bmatrix}. \tag{16}$$

For our decomposition we split the movements of the stocks into two parts. The first part is the changes in the long-run value of the state vector if the current flow probabilities remain unchanged. This often is referred to as the *flow steady-state* and it is the value $\bar{\boldsymbol{s}}_t$ for which $\Delta \boldsymbol{s}_t = \boldsymbol{0}$. For given matrices $\boldsymbol{d}_t$ and $\boldsymbol{P}_t$, it is equal to

$$\bar{\boldsymbol{s}}_t = -\boldsymbol{P}_t^{-1} \boldsymbol{d}_t \tag{17}$$

The second part is the changes in deviations from the steady state, $(\boldsymbol{s}_{t-1} - \bar{\boldsymbol{s}}_{t-1})$. The change

[22] The estimated transition probabilities are margin adjusted, using the method in Elsby *et al.* (2015) to satisfy these equations.

in the state vector is related to these two parts as follows

$$\Delta \boldsymbol{s}_t = \boldsymbol{P}_t \left(\boldsymbol{s}_{t-1} - \bar{\boldsymbol{s}}_t\right) = \boldsymbol{P}_t \left(\boldsymbol{s}_{t-1} - \bar{\boldsymbol{s}}_{t-1}\right) - \boldsymbol{P}_t \left(\bar{\boldsymbol{s}}_t - \bar{\boldsymbol{s}}_{t-1}\right). \tag{18}$$

Rearranging terms in (18), we can write the current deviation from the steady state as a function of the current change in the state vector. That is,

$$\begin{aligned} \left(\boldsymbol{s}_t - \bar{\boldsymbol{s}}_t\right) &= \left(\boldsymbol{I} + \boldsymbol{P}_t\right)\left(\boldsymbol{s}_{t-1} - \bar{\boldsymbol{s}}_{t-1}\right) - \left(\boldsymbol{I} + \boldsymbol{P}_t\right)\left(\bar{\boldsymbol{s}}_t - \bar{\boldsymbol{s}}_{t-1}\right) \\ &= \left(\boldsymbol{I} + \boldsymbol{P}_t\right)\boldsymbol{P}_t^{-1}\Delta \boldsymbol{s}_t \end{aligned} \tag{19}$$

This allows us to write the current change in the state as the sum of the transitional dynamics through the past change in the state and the changes in the steady state.

$$\Delta \boldsymbol{s}_t = \boldsymbol{P}_t \left(\boldsymbol{I} + \boldsymbol{P}_{t-1}\right) \boldsymbol{P}_{t-1}^{-1} \Delta \boldsymbol{s}_{t-1} - \boldsymbol{P}_t \Delta \bar{\boldsymbol{s}}_t. \tag{20}$$

The final step is to attribute the changes in the steady state, i.e., $\Delta \bar{\boldsymbol{s}}_t$ to changes in the different matrices made up of transition probabilities. For this, we use that

$$\Delta \boldsymbol{d}_t = -\frac{1}{2}\Delta \boldsymbol{P}_t \left(\bar{\boldsymbol{s}}_t + \bar{\boldsymbol{s}}_{t-1}\right) - \frac{1}{2}\left(\boldsymbol{P}_t + \boldsymbol{P}_{t-1}\right)\Delta \bar{\boldsymbol{s}}_t, \tag{21}$$

where

$$\Delta \boldsymbol{d}_t = \sum_{s\in\{E,U,N\}} \sum_{s'\in\{E,U,N\}} \frac{\partial \boldsymbol{d}_t}{\partial P_{s,s',t}} \Delta P_{s,s',t}, \text{ and } \Delta \boldsymbol{P}_t = \sum_{s\in\{E,U,N\}} \sum_{s'\in\{E,U,N\}} \frac{\partial \boldsymbol{P}_t}{\partial P_{s,s',t}} \Delta P_{s,s',t}. \tag{22}$$

Using this we can trace the change in the steady state back to changes in the flow transitions that drive $\Delta \boldsymbol{d}_t$ and $\Delta \boldsymbol{P}_t$, which yields

$$\Delta \bar{\boldsymbol{s}}_t = \left[\frac{1}{2}\left(\boldsymbol{P}_t + \boldsymbol{P}_{t-1}\right)\right]^{-1} \left[-\Delta \boldsymbol{d}_t - \frac{1}{2}\Delta \boldsymbol{P}_t \left(\bar{\boldsymbol{s}}_t + \bar{\boldsymbol{s}}_{t-1}\right)\right]. \tag{23}$$

Combining equations (20) and (23), we write the change in the state vector as the sum of transitional dynamics plus the changes in the steady state attributable to the six different flow transition probabilities.

$$\Delta \boldsymbol{s}_t = \boldsymbol{P}_t \left(\boldsymbol{I} + \boldsymbol{P}_{t-1}\right) \boldsymbol{P}_{t-1}^{-1} \Delta \boldsymbol{s}_{t-1} + \boldsymbol{P}_t \left(\boldsymbol{P}_t + \boldsymbol{P}_{t-1}\right)^{-1} \left[2\Delta \boldsymbol{d}_t + \Delta \boldsymbol{P}_t \left(\bar{\boldsymbol{s}}_t + \bar{\boldsymbol{s}}_{t-1}\right)\right] \tag{24}$$

This is a decomposition of changes in the state vector $\boldsymbol{s}_t$. The labor force participation rate is

$$LFPR_t = E_t + U_t = \boldsymbol{\iota}_2' \boldsymbol{s}_t, \tag{25}$$

where $\boldsymbol{\iota}_2$ is the 2-dimensional summation operator, i.e., a column vector with ones. The decomposition we use for the $LFPR_t$ is

$$\Delta LFPR_t = \boldsymbol{\iota}_2' \boldsymbol{P}_t \left(\boldsymbol{I} + \boldsymbol{P}_{t-1}\right) \boldsymbol{P}_{t-1}^{-1} \Delta \boldsymbol{s}_{t-1} + \boldsymbol{\iota}_2' \boldsymbol{P}_t \left(\boldsymbol{P}_t + \boldsymbol{P}_{t-1}\right)^{-1} \left[2\Delta \boldsymbol{d}_t + \Delta \boldsymbol{P}_t \left(\bar{\boldsymbol{s}}_t + \bar{\boldsymbol{s}}_{t-1}\right)\right] \tag{26}$$

A.2 Attachment Wedge

If those who are unemployed were as attached to the labor force as the employed, then the cyclical component would have no effect on participation. To understand this, it is important to realize that the current change in the LFPR is a distributed lag of current and past changes in the flow steady-state.[23] Because this lag structure is complicated, we focus on the change in the flow steady-state due to changes in the job-loss and job-finding rates, which we denote by $\Delta \overline{LFPR}_t^c$, to explain the intuition for what drives the cycle component in our decomposition. In Appendix A, we show that this equals

$$\Delta \overline{LFPR}_t^c = -\frac{1}{D_t} \overline{LFPR}_t \left(\bar{P}_{U,N,t} - \bar{P}_{E,N,t}\right) \left(\left(1 - \bar{u}_t\right) \Delta P_{E,U,t} - \bar{u}_t \Delta P_{U,E,t}\right), \tag{27}$$

where $\overline{LFPR}_t$ is the flow steady-state labor force participation rate and $\bar{u}_t$ is the flow steady-state unemployment rate, both averaged across periods t and $t-1$. D_t is the determinant of $\bar{\boldsymbol{P}}_t = 1/2 \left(\boldsymbol{P}_t + \boldsymbol{P}_{t-1}\right)$, $\bar{P}_{E,N,t} = 1/2 \left(P_{E,N,t} + P_{E,N,t-1}\right)$, and $\bar{P}_{U,N,t} = 1/2 \left(P_{U,N,t} + P_{U,N,t-1}\right)$.[24] The third and fourth terms of this expression are the ones that matter the most for the intuition of what drives the participation cycle.

The third term is the difference between the rate that unemployed and employed workers leave the labor force: $\left(\bar{P}_{U,N,t} - \bar{P}_{E,N,t}\right)$. We refer to this term as the *attachment wedge*. It captures the difference in the attachment to the labor force of those unemployed versus those employed. It is positive because the employed are more attached to the labor force than the unemployed, i.e., $\bar{P}_{U,N,t} > \bar{P}_{E,N,t}$. A positive attachment wedge is necessary for a procyclical participation cycle.

The fourth term, $\left(\left(1 - \bar{u}_t\right) \Delta P_{E,U,t} - \bar{u}_t \Delta P_{U,E,t}\right)$, is the change in the flow steady-state unemployment rate due to changes in the job-loss and job-finding rates. It captures the shift in the

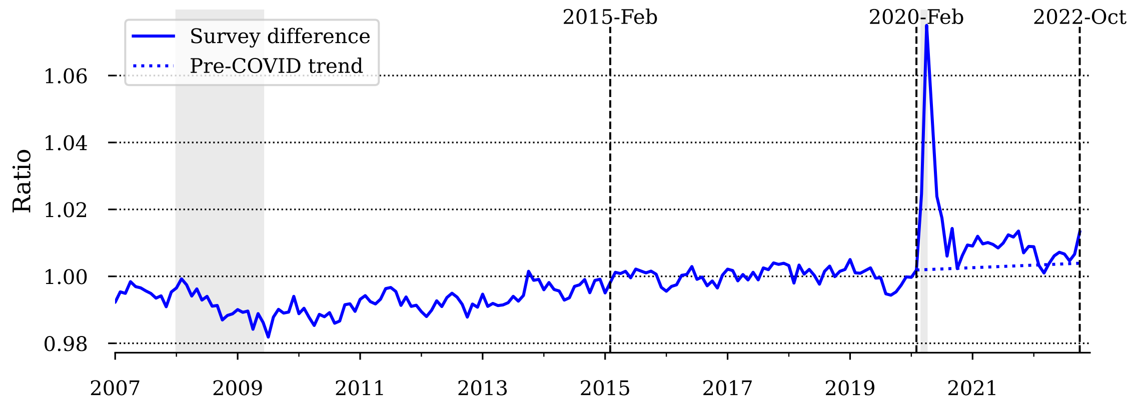
[23] See Appendix A for a derivation of this lag expression.

[24] The determinant D_t is positive in all periods for the observed transition probabilities in the data.

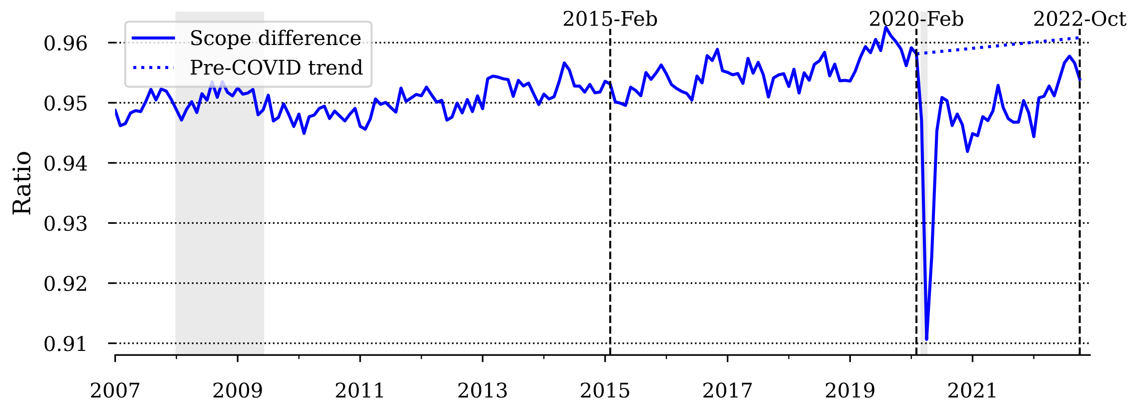
composition of the labor force between unemployed and employed that is solely due to movements of persons between these two states and not due to movements across the participation margin.

Equation (27) is important because it shows that, to understand the procyclicality of the participation rate, it is essential to study the likelihood of workers exiting the labor force rather than workers entering the labor force. This likelihood is affected by the labor force status of individuals within the labor force since there is a quantitatively important attachment wedge between the unemployed and employed.

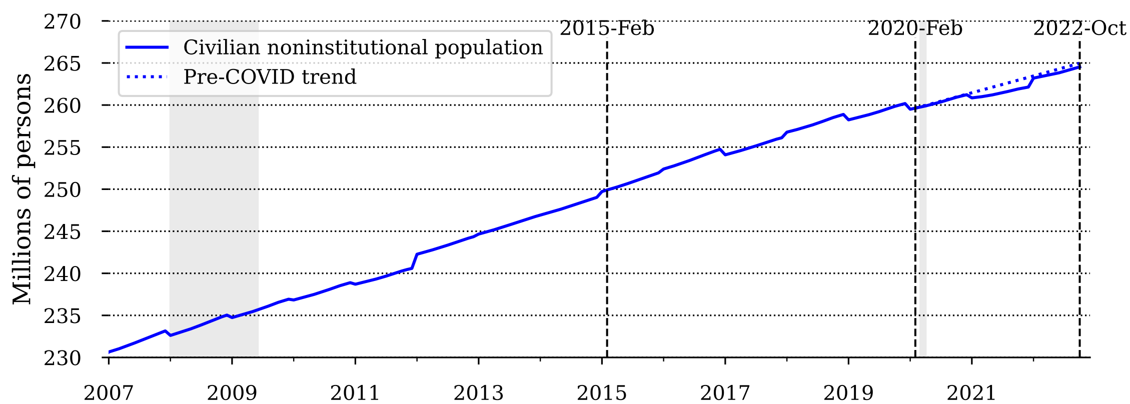
B Additional empirical results



(a) Survey difference



(b) Scope difference



(c) Civilian noninstitutional population

Figure B.1: Survey difference, scope difference, and population growth (with pre-COVID trend)

Source: BLS and author's calculations.