$u^* = \sqrt{uv}$:
The Full-Employment Rate of Unemployment in the United States

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ABSTRACT This paper computes the unemployment rate u^* that is consistent with full employment in the United States. First, the paper argues that social efficiency is the most appropriate economic interpretation of the legal concept of full employment. Here efficiency means minimizing the nonproductive use of labor—both unemployment and recruiting. As it takes one worker to service one job vacancy, the nonproductive use of labor is measured by the number of jobseekers and job vacancies, $u + v$. Through the Beveridge curve, the numbers of jobseekers and vacancies are inversely related, uv = constant. With such symmetry the labor market is efficient when there are as many jobseekers as vacancies ($u = v$), inefficiently tight when there are more vacancies than jobseekers ($v > u$), and inefficiently slack when there are more jobseekers than vacancies ($u > v$). Accordingly, the full-employment rate of unemployment (FERU) is the geometric average of the unemployment and vacancy rates: $u^* = \sqrt{uv}$. From 1930 to 2024, the FERU averages 4.1% and is stable, remaining between 2.5% and 6.7%. Unemployment has generally been above the FERU ($u > u^*$), especially during recessions. Unemployment has only been below the FERU ($u < u^*$) during major wars, as well as shortly before and in the aftermath of the pandemic.

In the United States the federal government and central bank are mandated to maintain the economy at "full employment," or "maximum employment." This legislative mandate comes from the Employment Act of 1946, the Federal Reserve Reform Act of 1977, and the Full Employment and Balanced Growth Act of 1978 (Duboff 1977; Ginsburg 1979; Weir 1987; Steelman 2011; Bernanke

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2013). For instance, the Employment Act states that it is the "policy and responsibility of the federal government. . . to coordinate and utilize all its plans, functions, and resources. . . to promote maximum employment" (US Congress 1946, p. 1). The Federal Reserve Reform Act of 1977 adds that it is the responsibility of the Federal Reserve "to promote effectively the goals of maximum employment, stable prices" (US Congress 1977, p. 1387). Finally, the Full Employment and Balanced Growth Act of 1978 was written to "assert the responsibility of the Federal Government to use all practicable programs and policies to promote full employment" (US Congress 1978, p. 1887).[1] In this paper, we aim to compute the unemployment rate that characterizes a state of full or maximum employment. We denote it by u^* and, following Meade (1982), we refer to it as the full-employment rate of unemployment (FERU).

Our first task is to translate the legal notion of full employment into economic terms. Since the Employment Act and Full Employment and Balanced Growth Act clearly state that achieving full employment is a way to maximize social welfare, we translate full employment as social efficiency. Indeed, the Employment Act states that reaching full employment is designed "to foster. . . the general welfare" (US Congress 1946, p. 1). The Full Employment and Balanced Growth Act adds that when the economy departs from full employment, it "is deprived of the full supply of goods and services, the full utilization of labor. . . and the related increases in economic well-being that would occur under conditions of genuine full employment" (US Congress 1978, p. 1888).

We therefore compute the FERU as the unemployment rate that achieves a socially efficient allocation of labor. This allocation maximizes social output by minimizing the uses of labor that are socially unproductive: both jobseeking and recruiting. The goal is that workers spend as much time as possible producing socially useful things and waste as little time as possible searching for jobs or new hires. Of course, jobseeking and recruiting are necessary for workers and firms to match with each other, but they do not generate any social welfare by themselves.

The FERU maximizes social output: goods and services produced in the market and at home that engender social welfare. In theory, unemployed workers might produce valuable goods and services at home while looking for jobs. But in practice, the benefits from home production are almost entirely offset by the psychological costs from being unemployed, so the social product of unemployed labor is minimal (Michaillat and Saez 2021a; Hussam and others 2022). Furthermore, not all employed workers produce social output. Many workers devote their time to recruiting instead of producing goods and services that add to social welfare. In fact, it takes about one full-time worker to service one job vacancy, so the number of recruiters can be counted by the number of vacancies (Gavazza, Mongey, and Violante 2018; Michaillat and Saez 2021a). Accordingly, the share

[1]During the debate preceding the Employment Act, maximum employment was considered a less stringent goal than full employment (Duboff 1977, p. 6). In 1978, the Full Employment and Balanced Growth Act amended the Employment Act and replaced maximum employment by the more ambitious target of full employment (Weir 1987, p. 398).

of socially productive workers in the labor force is $1 - u - v$, where u is the unemployment rate and v is the vacancy rate. The FERU, therefore, minimizes the sum of the unemployment and vacancy rates, $u + v$.

A naive way to minimize $u + v$ would be to set the unemployment rate u and vacancy rate v to zero. But it is impossible to simultaneously reduce the numbers of jobseekers and job vacancies because of the Beveridge curve. When the number of jobseekers falls along the Beveridge curve, the number of vacancies necessarily rises; conversely, when the number of vacancies falls, the number of jobseekers necessarily rises. In fact, the Beveridge curve is approximately a rectangular hyperbola: $uv = A$, where $A > 0$ is a constant (Michaillat and Saez 2021a). Hence, it is infeasible to set the unemployment and vacancy rates to zero, or even to reduce them simultaneously.

In sum, the efficient allocation minimizes $u + v$ subject to $uv = A$. Because of the symmetrical roles played by jobseekers and vacancies, the efficient allocation must have as many jobseekers as vacancies. This is equivalent to saying that the economy is at full employment when there are as many jobseekers as vacancies ($u = v$). A further consequence is that the labor market is inefficiently tight when there are more vacancies than jobseekers ($v > u$), and inefficiently slack when there are more jobseekers than vacancies ($u > v$).

For policymakers seeking to communicate a single, clear indicator, the full-employment criterion can be expressed using labor-market tightness, defined as the number of job vacancies per jobseeker, v/u. Our analysis shows that when tightness equals 1, the economy is at full employment. When tightness exceeds 1, the labor market is inefficiently tight. When tightness falls below 1, it is inefficiently slack. Thus, tightness alone suffices to indicate whether the economy is at full employment, with the added advantage that the full-employment tightness takes an intuitive value: 1.

Because we are used to thinking about unemployment rather than tightness, and because we have a better idea of the effects of stabilization policies on unemployment than on tightness, it is still useful to construct the rate of unemployment at full unemployment—the FERU. From the Beveridge curve and the equality of the efficient unemployment and vacancy rates, we deduce that the FERU is the geometric average of the unemployment and vacancy rates: $u^* = \sqrt{uv}$. As it only requires unemployment and vacancy rates, the FERU formula is easy to apply, even in real time. We derived a more general but also more complex formula in Michaillat and Saez (2021a). Here we show that empirically, the relevant parameters align so that the general formula can be greatly simplified. This provides an incredibly simple, easy to derive, and easy to use formula—which might be useful to policymakers.

Computing the FERU in the United States between 1930 and 2024, we find that the FERU averages 4.1%. The FERU is also quite stable: it remains between 2.5% and 6.7%, while the unemployment rate fluctuates between 1.0% and 25.3%.

Furthermore, the unemployment rate has generally been above the FERU, meaning that the

US labor market has generally been inefficiently slack. The unemployment gap $u - u^*$ averages +2.3pp. The gap is especially wide in recessions—as wide as +20.9pp during the Great Depression and +5.9pp during the Great Recession. The US labor market has only been inefficiently tight during major wars—World War 2, Korean War, and Vietnam War—and around the coronavirus pandemic—from 2018Q3 to 2020Q1 and then from 2021Q3 to 2024Q2.

As the FERU formula can be applied in real time, we can use it to examine the US labor market during and after the coronavirus pandemic. We observe that the pandemic labor market has been extremely unusual. First, in 2020, the unemployment gap reached +6.3pp. The last time the economy faced such slack was 1940, at the onset of World War 2. Then, in 2022, the unemployment gap bottomed to −1.5pp. The last time the economy became so tight was 1945, at the end of World War 2.

I. Existing unemployment targets

Before beginning the analysis, we review existing unemployment targets used by policymakers and argue that they do not align well with the US government's full-employment mandate.

I.A. Numerical targets

In the early postwar period, right after the Employment Act established the full-employment mandate and created the Council of Economic Advisers (CEA) to enforce it, several numerical values were used as full-employment targets. From 1946 to 1956, the CEA used an unemployment rate of 3% as a marker of full employment (Duboff 1977, p. 8). Then the CEA started raising their unemployment target. In 1962, the CEA wrote that an unemployment rate of 4% was "a reasonable and prudent full employment target for stabilization policy" (Duboff 1977, p. 10). Then, in 1969, Burns (1969, p. 280) reported that "Since the [CEA] identified an unemployment rate of 4% with a condition of practically full employment, this figure served as a constant in the equation for computing the potential output."

A first issue with a numerical target is that it lacks a theoretical foundation. Hence, it is unclear what the target means or whether it accurately represents full employment. Policymakers recognized this limitation at the time. Even before becoming chairman of the Fed, Arthur Burns argued that the 4% target was not compelling because it did not incorporate information on job vacancies. For instance, Burns (1962, p. 17) wrote that "A serious need remains for strengthening the statistical machinery of the Employment Act.. . . In seeking to discriminate between structural changes as one possible cause of unemployment and deficiency of aggregate demand as another, we are still frustrated by an almost complete absence of statistics on job vacancies." Burns (1969, p. 284) added that "we need to develop comprehensive data on job vacancies, so that it will no longer be necessary to guess whether or when a deficiency in aggregate demand exists." In 2001, the US government started collecting data on job vacancies through the Job Opening and Labor Turnover Survey (JOLTS). In this paper, we combine data on job vacancies and unemployment to compute the unemployment rate consistent with full employment.

A second issue with a numerical target is that it is unclear when and how the target should change. Policymakers became aware of these limitations when the unemployment started rising in the 1970s. It was not clear whether the target should rise too, so the CEA moved away from a numerical target for full employment. When testifying in front of Congress in 1975, Alan Greenspan, who was then chairing the CEA, was asked what the target for full employment was. He responded: "I do not think we should set a target" (Duboff 1977, p. 13).

I.B. NAIRU

In recent times, the US government has used the non-accelerating-inflation rate of unemployment (NAIRU) as full-employment target. For instance, the US Joint Economic Committee (2019, p. 2) recently wrote that "Today, full employment is considered by many to be synonymous with the non-accelerating inflationary rate of unemployment (NAIRU)—the rate of unemployment that neither stokes nor slows inflation." Similarly, the US Council of Economic Advisers (2024, p. 24) described the concept of full employment as follows: "Modern economics has generally defined full employment by citing the theoretical concept of the lowest unemployment rate consistent with stable inflation, which is referred to as u^*, . . . the non-accelerating inflationary rate of unemployment (termed NAIRU)." These quotes are particularly meaningful because they come from the Joint Economic Committee and Council of Economic Advisers, which were both created by the Employment Act of 1946 to ensure that the government achieved its employment mandate. Fed Chair Powell (2022, p. 6) offered the same definition of full employment: "Most FOMC participants agree that labor market conditions are consistent with maximum employment in the sense of the highest level of employment that is consistent with price stability."

The NAIRU is the unemployment rate at which inflation remains stable. It is measured by estimating Phillips curves (Staiger, Stock, and Watson 1997; Gordon 1997; Laubach 2001; Ball and Mankiw 2002; Orphanides and Williams 2002; Crump and others 2019).

Although the NAIRU contains information relevant to the Fed's price-stability mandate, it does not represent the efficient rate of unemployment (Rogerson 1997, p. 90). In modern models of the labor market, workers and firms meet through a matching function and form long-term employment relationships (Pissarides 2000). In these models, infinitely many real wages are acceptable in equilibrium (Hall 2005). However, only one of those wages yields the efficient rate of unemployment. There is no guarantee that the real wage arising under stable inflation coincides with this efficient real wage (Blanchard and Gali 2010). Accordingly, there is no guarantee that the unemployment rate prevailing under stable inflation—the NAIRU—is efficient. Since we have defined full employment as a socially efficient allocation of labor, the NAIRU cannot be a measure of full employment.

I.C. CBO's NRU

Another full-employment target used by the US government is the natural rate of unemployment (NRU)—which has been rebranded noncyclical rate of unemployment since 2021—constructed by the Congressional Budget Office (CBO). For example, when he was President of the Boston Fed, Rosengren (2014, p. 180) measured the departure of the Fed from its full-employment mandate by "the squared deviations of unemployment from an estimate of full employment utilizing the Congressional Budget Office assessment of the natural rate for each year." Similarly, Powell (2018) argues that policymakers should navigate using the natural rate of unemployment u^* as a guide. For instance, when "the unemployment rate is above u^*", the Fed should "lower the real federal funds rate . . . which will stimulate spending and raise employment." To illustrate what u^* was from 1960 to 2000, and how it had fluctuated, Powell (2018, figure 2) plots the CBO's NRU.

The CBO's NRU is a slow-moving trend of the unemployment rate computed by assuming that the labor market was at full employment in 2005, and then by incorporating changes in the demographic composition of the labor force over time (Shackleton 2018, appendix B).

Although the NRU conveys information about the demographic forces exerted on the labor market, without a theory of full employment, it is impossible to know whether the US labor market really was at full employment in 2005, and by induction, whether the NRU in any year measures full employment. Thus, the CBO's NRU cannot be a satisfactory measure of full employment.

I.D. Daly and others (2012)'s NRU

Daly and others (2012) propose an alternative method to measure the NRU based on the Beveridge curve. Daly and others start from the empirical Beveridge curve, which they take as given. Then they estimate a long-run level of labor-market tightness, which would prevail in the absence of business-cycle shocks.[2] Finally, they read the NRU at the intersection of the empirical Beveridge curve and the estimated long-run tightness (Daly and others 2012, figure 4).

The issue is that in the matching model on which their analysis is based, there is no guarantee that long-run tightness is efficient, so there is no guarantee that this NRU is the efficient rate of unemployment (Pissarides 2000, p. 185). As we have defined full employment as a socially efficient allocation of labor, the NRU cannot be a satisfactory measure of full employment. Instead, the NRU

[2] Daly and others (2012) estimate a long-run job-creation curve. But in the job-creation curve is just a line whose slope is labor-market tightness (Pissarides 2000, chapter 1). So estimating a long-run job-creation line is tantamount to estimating a long-run tightness.

computed by Daly and others (2012) measures the noncyclical, structural rate of unemployment given the Beveridge curve.

I.E. Other targets

In recent years, other full-employment targets have been developed to guide policymakers (Crump, Nekarda, and Petrosky-Nadeau 2020). These targets either guarantee stable prices, like the NAIRU, or reflect a slow-moving trend of unemployment, like the CBO's and Daly and others (2012)'s NRU. They are not designed to measure the rate of unemployment that maximizes social welfare (as Crump, Nekarda, and Petrosky-Nadeau 2020, p. 5 rightfully note), so they cannot satisfactorily measure full employment.

II. Derivation of the FERU formula

Based on the legislation that introduced the full-employment mandate in the United States, we defined the FERU as the rate of unemployment that achieves a socially efficient allocation of labor. Therefore, the FERU is the solution to the problem of a social planner who allocates labor to maximize welfare. We now describe this problem and solve it to derive the FERU formula.

II.A. Social welfare function

The social planner allocates labor to maximize social output. Social output is the production of goods and services that generate social welfare. We have said that the social planner aims to maximize social welfare. But for simplicity, we leave out distributional considerations from the social welfare function, so social welfare is determined by social output.[3] This perspective on full employment is consistent with the view expressed by Beveridge (1944, p. 20) that "The material end of all human activity is consumption. Employment is wanted as a means to more consumption. . . as a means to a higher standard of life."

II.B. Workers available for production

We assume that the social planner has the entire labor force at its disposal for production. This assumption aligns with the legislation behind the full-employment mandate, which intends to provide employment opportunities for all labor-force participants. For instance, the Employment Act says

[3]Distributional considerations can be excluded by assuming that workers are risk neutral. If workers are risk averse and are not perfectly insured against unemployment, then the distribution of consumption influences welfare, and the efficient unemployment rate is given by a more complex formula that incorporates distributional elements (Landais, Michaillat, and Saez 2018a).

that it aims to afford “useful employment opportunities, including self-employment, for those able, willing, and seeking to work” (US Congress 1946, p. 1). The Full Employment and Balanced Growth Act uses similar language. Its goal is to “translate into practical reality the right of all Americans who are able, willing, and seeking to work to full opportunity for useful paid employment” (US Congress 1978, p. 1887). Thus, the labor force represents the pool of workers that the social planner can tap into for production. People out of the labor force may be in school or in training, may have retired, or may be looking after their family. They are not available to the planner for production.

Although the planner takes the labor force as given, she might have to account for changes in the size of labor force if that size systematically responded to the state of the labor market. In practice, however, the labor-force participation rate is acyclical, so the planner takes the labor-force size as fixed. Using US data covering 1946–1954, Rees (1957, p. 32) does not find evidence of the discouraged-jobseeker theory. More systematically, in US data covering 1960–2006, Shimer (2009, p. 294) finds that the labor-force participation rate is acyclical. Similarly, using US data spanning 1976–2009, Rogerson and Shimer (2011, pp. 624–625) find that over the business cycle, “the labor force participation rate is nearly constant.” Erceg and Levin (2014, p. 19) also find that the labor-force participation rate is acyclical in the United States between 1972 and 2007.[4] Finally, using a vector autoregression ran on US data for 1976–2016, Cairo, Fujita, and Morales-Jimenez (2022, figure 1C) find that the impulse response of the labor-force participation rate to a positive productivity shock (the typical shock in business-cycle models) is zero for two years, and while it is slightly positive after two years, it is never significantly different from zero.[5]

II.C. Social product of employed labor

We have said that the planner has the entire labor force at its disposable for production. Among those are workers employed by firms and jobseekers. We start by assessing the social product of employed workers.

Employed workers must spend some of their time recruiting new hires for their firms, so they are unable to spend their entire time contributing to social output. Recruiting takes work: designing and advertising job vacancies, screening and interviewing candidates, and negotiating contracts. Beside recruiting, employed workers might also spend time looking for a new job, which takes further time away from socially productive tasks.

There are two sources of information about the amount of labor devoted to recruiting in the United States. The first source is the National Employer Survey, which was conducted by the

[4]Erceg and Levin (2014) argue that high unemployment during the Great Recession caused a drop in labor-force participation. But as Aaronson and others (2014) and Krueger (2017) show, the decline in labor-force participation was primarily caused by population aging and other trends that preceded the Great Recession.

[5]In fact, section IV.A shows that the FERU formula is not modified when we endogenize the labor-force participation rate and allow it to respond to labor-market conditions.

Census Bureau in 1997 (Villena Roldan 2010). The survey asked thousands of establishments across industries about their recruiting practices (Cappelli 2001). Using the survey, Michaillat and Saez (2021a, p. 11) estimate that servicing a job vacancy requires 0.92 worker at any point in time.

A second source is the survey conducted by the consulting firm Bersin and Associates in 2011 (Gavazza, Mongey, and Violante 2018). The survey asked over 400 firms with more than 100 employees about their spending on all recruiting activities. Gavazza, Mongey, and Violante (2018, p. 2106) find that recruiting one worker costs 0.928 of a monthly wage. To translate this number into the labor cost of servicing a job vacancy, we assess the time it took to fill a vacancy in 2011. On an average month in 2011, there were 4.305 million hires and 3.430 million vacancies (US Bureau of Labor Statistics 2024c,f). Therefore, vacancies were filled at a monthly rate of $q = 4.305/3.430 = 1.25$, and vacancies stayed open on average for $1/q = 1/1.25 = 0.80$ month. These results imply that it takes $0.928/0.80 = 1.16$ workers to service a vacancy.

The two surveys show that it takes about 1 full-time worker to service a job vacancy—maybe a bit less or maybe a bit more.[6] In other words, the number of recruiters in the United States is well measured by the number of vacancies. So the number of workers diverted from producing and allocated to recruiting can be measured by the number of vacancies open at any point in time.

Employed workers might also be distracted from producing if they search for new jobs at work. However, the average time spent on job search by employed workers is only 31 seconds per day (Ahn and Shao 2020, table 1). So on-the-job search is a tiny amount taken away from production, and we abstract from it here.

II.D. Social product of unemployed labor

Next, we assess the social product of unemployed labor. We consider three possible activities for unemployed workers. The first is looking for a job. Jobseeking is required to find employment but—just like recruiting—it does not contribute to social output. The second is producing goods and services at home. Home production adds to social output and contributes to social welfare. The third is remaining idle when not looking for jobs or producing at home.

The value of jobseekers' home production, net of the psychological cost of idleness, is estimated to be negligible. Using administrative data from the US military, Borgschulte and Martorell (2018) study how servicemembers choose between reenlisting and leaving the military. The choices allow them to estimate the value of home production plus public benefits minus the psychological cost of idleness during unemployment. Subtracting the value of public benefits from these estimates, Michaillat and Saez (2021a, p. 11) find that the value of home production minus the psychological cost of idleness could be as low as 3% of the value of market production.

[6] Section IV.B shows how to extend the FERU formula if the number of recruiters per vacancy is different from 1.

Given its minimal value, we set the social product of unemployed labor to 0.[7] The unproductivity of unemployment was already noted by Robinson (1949, p. 11): "The most important aspect of unemployment is its wastefulness. It is the existence of unused productive resources side by side with unsatisfied human needs that is the intolerable condition."

Where do the psychological costs of unemployment come from? The psychological costs associated with unemployment arise from various sources. First, depression, anxiety, and strained personal relations are common consequences of job loss (Eisenberg and Lazarfeld 1938; Theodossiou 1998). Job loss is a traumatic event that can lead to a decline in an individual's self-esteem and sense of self-worth (Goldsmith, Veum, and Darity 1996). Joblessness also diminishes psychological well-being by creating a sense of helplessness: that one's life is no longer under their control (Goldsmith and Darity 1992). Furthermore, job search appears to reduce unemployed workers' life satisfaction (Krueger and Mueller 2011). In fact, Jahoda (1981) emphasizes numerous important benefits of work—which are lost during unemployment. These benefits from work encompass a structured daily routine, regular interactions and shared experiences with individuals beyond the immediate family, the pursuit of overarching goals and purposes, a source of personal status and identity, and the engagement in regular activities. Collectively, the loss of these benefits contributes to the psychological burdens associated with unemployment.

That the idleness associated with unemployment can create psychological hardship goes against the idea—standard in economics—that unemployed workers enjoy leisure time. Yet, even though it is often neglected in economics, the psychological toll from unemployment has been understood for a long time. Robinson (1949, p. 11) for instance observed that "The most striking aspect of unemployment is the suffering of the unemployed and their families—the loss of health and morale that follows loss of income and occupation." At this point, the detrimental effects of unemployment on mental and physical health are well documented (Dooley, Fielding, and Levi 1996; Platt and Hawton 2000; Frey and Stutzer 2002; Wanberg 2012; Brand 2015).

A field experiment in Bangladesh by Hussam and others (2022) illustrates just how large the psychosocial cost of unemployment is. The experiment shows that paid employment raises psychosocial well-being substantially more than the same amount of cash alone. In fact, two-thirds of employed workers would be willing to forgo cash payments and continue working for free.

II.E. Shape of the Beveridge curve

Given that both unemployed workers and vacant jobs are socially costly, the social planner would want to reduce both. This is not feasible, however, because of the Beveridge curve, which imposes that the numbers of jobseekers and job vacancies are negatively related. When the economy is in a

[7] Section IV.B shows how to extend the FERU formula if the social product of unemployed labor is nonzero.

slump, there are a lot of jobseekers and few vacancies. Conversely, when the economy is in a boom, there are few jobseekers and many vacancies.

Looking at labor-market data for Great Britain, Beveridge (1944) first observed that the numbers of job vacancies and jobseekers move in opposite directions. Dow and Dicks-Mireaux (1958, figures 1 and 2) confirmed Beveridge's observation by plotting unemployment and vacancy data for Great Britain, 1946–1956. The data reveal that, over time, the unemployment rate increases whenever the vacancy rate declines, and vice versa.

The Beveridge curve holds remarkably well in the United States (Blanchard and Diamond 1989; Elsby, Michaels, and Ratner 2015). Figure 1A depicts the unemployment and vacancy rates in the United States between 1951 and 2019. The unemployment rate is number of jobseekers divided by size of the labor force. The vacancy rate is the number of vacancies divided by size of the labor force. The figure shows that unemployment and vacancy rates move in opposite directions: the unemployment rate is sharply countercyclical, while the vacancy rate is clearly procyclical. The unemployment and vacancy data plotted here are produced by the US Bureau of Labor Statistics (2024k,a,f) and Barnichon (2010), and they are widely used (Daly and others 2012; Diamond and Sahin 2015; Elsby, Michaels, and Ratner 2015; Barnichon and Figura 2015; Ahn and Crane 2020; Petrosky-Nadeau and Zhang 2021; Barlevy and others 2024; Michaillat and Saez 2021a, 2024b). We will come back to the construction of these data in section III.A.

In fact, unemployment and vacancy rates appear not only to be negatively related, but to be the inverse of each other. So doubling the unemployment rate cuts the vacancy rate in half, and conversely, doubling the vacancy rate cuts the unemployment rate in half. Figure 1B displays again unemployment and vacancy rates, but now on a logarithmic scale. The fluctuations of the unemployment and vacancy rates are a mirror image of each other, indicating that unemployment and vacancy rates are inversely related.

Mathematically, the property that the unemployment rate $u \in [0, 1]$ and vacancy rate $v \in [0, 1]$ are inversely related implies that the Beveridge curve is a rectangular hyperbola:

$$vu = A,$$

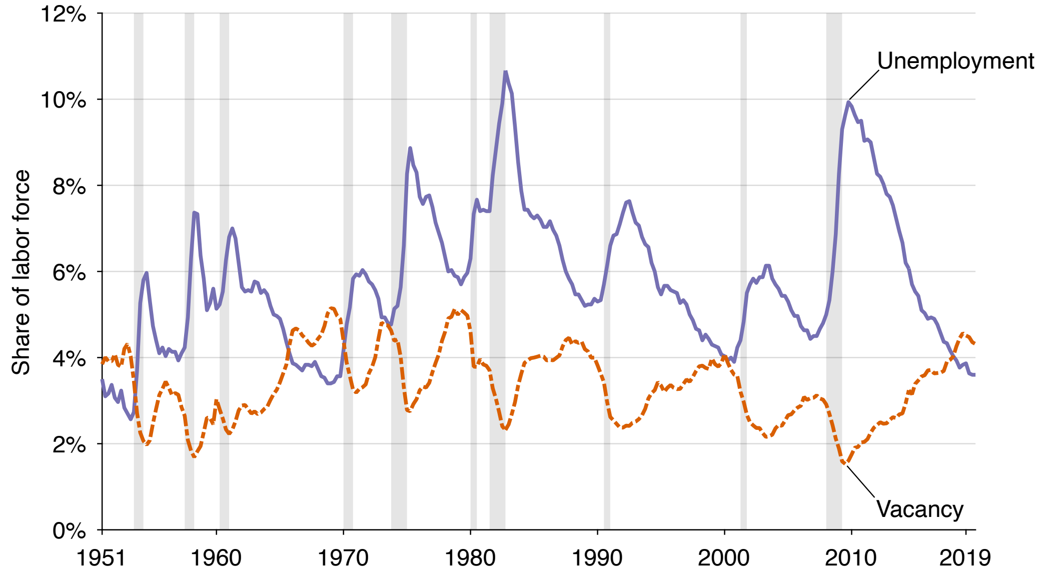
where $A \in (0, 1/4)$ is a constant.[8]

We can formally establish that the Beveridge curve is a rectangular hyperbola by estimating the elasticity of the vacancy rate with respect to the unemployment rate, $d\ln(v)/d\ln(u)$. An elasticity of -1 corresponds to a hyperbola. Using the algorithm of Bai and Perron (1998), and the data displayed

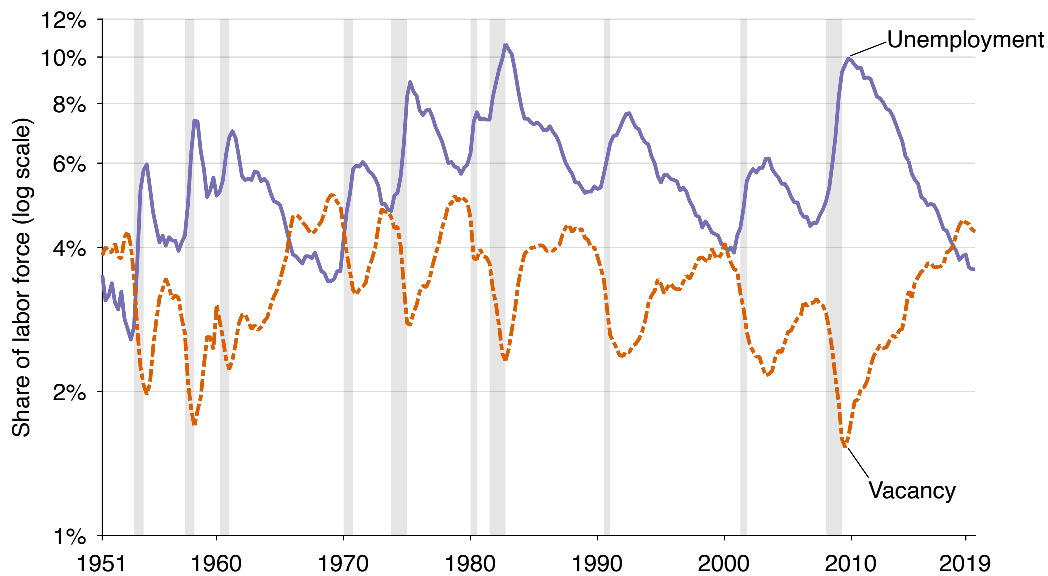
[8]We impose the condition $A < 1/4$ so the equation $vu = A$ admits at least a solution (u, v) such that $u + v \leq 1$. The condition $u + v \leq 1$ must hold because the number of jobseekers and recruiters is less than the number of labor-force participants. To see where the upper bound $1/4$ comes from, consider the point on the Beveridge curve such that $u = v$. That point satisfies $u^2 = A$ or $u = \sqrt{A}$, and $v = u = \sqrt{A}$. The constraint $u + v \leq 1$ translate into $2\sqrt{A} \leq 1$, which is equivalent to $A \leq 1/4$. By imposing $A < 1/4$, we ensure that parts of the Beveridge curve satisfy the constraint $u + v \leq 1$.

Figure 1. Unemployment and vacancy rates in the United States, 1951Q1–2019Q4

Panel A: Linear scale



Panel B: Logarithmic scale



Sources: The unemployment rate is measured by the US Bureau of Labor Statistics (2024k). Between 1951Q1 and 2000Q4, the vacancy rate is constructed by Barnichon (2010); between 2001Q1 and 2019Q4, the vacancy rate is the number of job openings divided by the civilian labor force, both measured by the US Bureau of Labor Statistics (2024a,f). Unemployment and vacancy rates are quarterly averages of monthly series. The gray areas are recessions dated by the National Bureau of Economic Research (2023).

in figure 1, Michaillat and Saez (2021a, figures 5 and 6) estimate the structural breaks of the US Beveridge curve, and the elasticity of the Beveridge curve between these breaks. They find that over the 1951–2019 period, the Beveridge elasticity remains between -0.84 and -1.02, so never far from -1. This finding confirms that the US Beveridge curve is close to a rectangular hyperbola.[9]

Graphically, it is evident that the US Beveridge curve closely resembles a rectangular hyperbola. The branches of the Beveridge curve identified by Michaillat and Saez (2021a, figure 5) are plotted on figure 2. The US labor market typically stays on one branch for a decade or more before the Beveridge curve abruptly shifts to a new location (a sudden change in A). On each panel, the solid, straight line represents a rectangular hyperbola. Since the panels plot the unemployment and vacancy rates on logarithmic scales, the hyperbola appears as a downward-sloping line with a slope of -1. Across all panels, the Beveridge curve aligns closely with the rectangular hyperbola.

It is quite natural that the Beveridge curve takes the shape of a rectangular hyperbola, since it is the shape that arises in a basic matching model of the labor market. In the model, the Beveridge curve is the locus of points such that labor-market flows are balanced: the number of workers who lose or quit their jobs equals the number of workers who find a job. The employment rate $1 - u$ is approximately constant at 1 since the unemployment rate u is an order of magnitude less than 1. The job-separation rate λ is also constant, so the number of job separations $\lambda(1 - u)$ is approximately constant at λ. So along the Beveridge curve, the number of workers who find a job is constant at λ. With the standard symmetric Cobb-Douglas matching function, $m = \omega\sqrt{uv}$, the number of workers who find a job at any point in time is proportional to $\sqrt{uv}$.[10] Hence, along the Beveridge curve, $\sqrt{uv}$ and thus uv must be constant: the Beveridge curve is a rectangular hyperbola.

We have just provided a foundation for the hyperbolic Beveridge curve based on a basic matching model, but the analysis is in no way limited to that model. Our analysis only presumes that the Beveridge curve exists—it does not put additional restrictions on the structure of the labor market. For instance, the basic matching model only features labor flows between employment and unemployment. In practice, there are vast labor flows in and out of the labor force, and from employment to employment (Blanchard and Diamond 1990, figure 1). Our analysis applies to all models with such labor flows as long as they feature a Beveridge curve.[11]

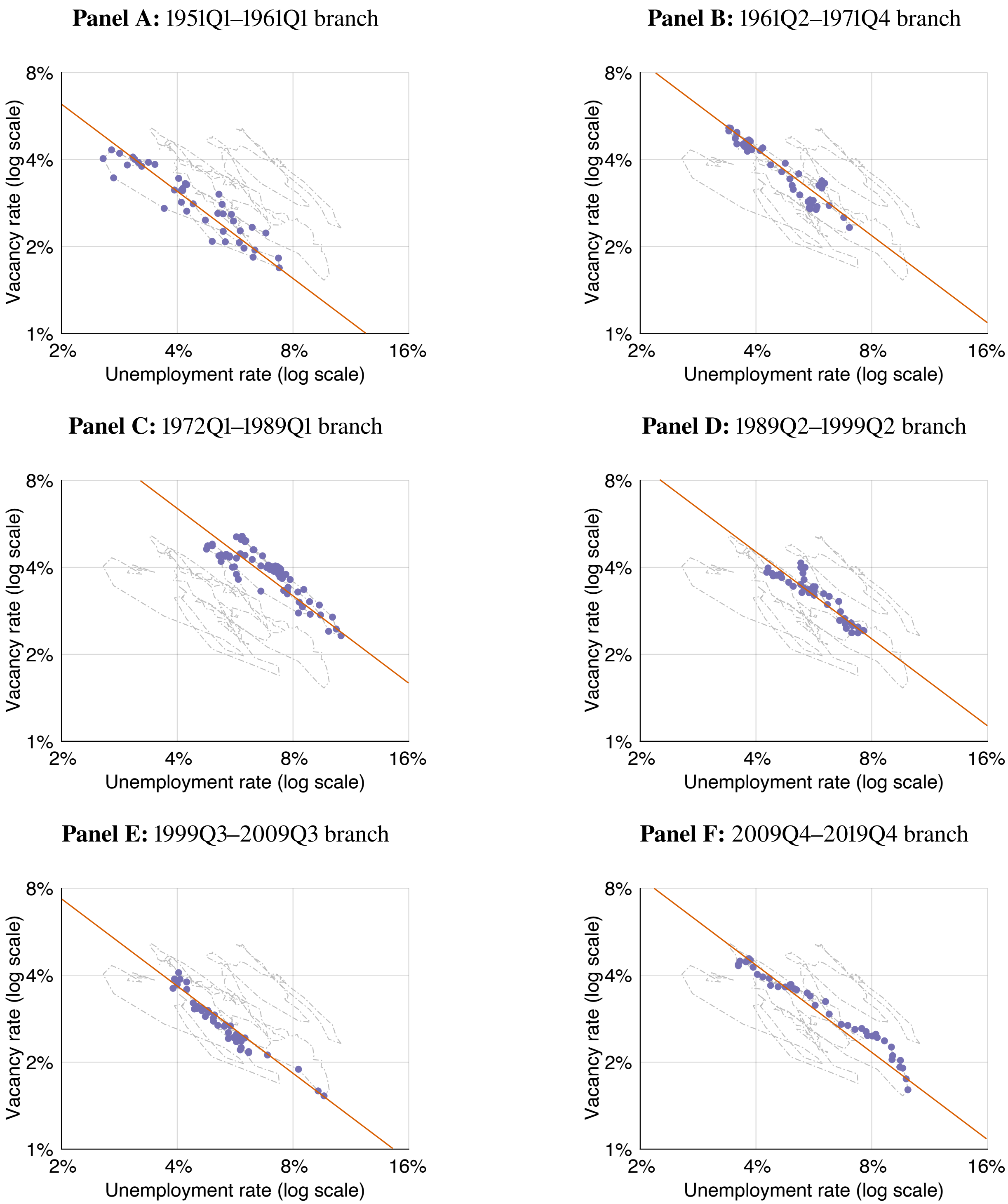
Similarly, the basic matching model assumes that firms recruit workers only from unemployment. In reality, firms also recruit workers from other employers and outside the labor force. Fortunately,

[9] Section IV.B shows how to extend the FERU formula if the Beveridge curve is an isoelastic curve with an elasticity different from -1.

[10] The US matching function appears to have a Cobb-Douglas form with exponents of 0.5 on unemployment and vacancies (Michaillat and Saez 2021a, p. 9).

[11] An implicit assumption is that all workers have the same productivity across all firms. Therefore, job-to-job and labor-force transitions do not affect the output of transitioning workers or overall welfare. (Since the labor force has constant size, any worker exiting the labor force is replaced by a new worker entering it. For example, a worker going on parental leave is replaced by one returning from parental leave.)

Figure 2. The US Beveridge curve approximates a rectangular hyperbola



Sources: Unemployment and vacancy rates come from figure 1. The structural breaks between branches of the Beveridge curve are estimated by Michaillat and Saez (2021a, figure 5) using the algorithm of Bai and Perron (1998). The solid, straight lines are rectangular hyperbolas $uv = A$, where the constant A is specific to each branch.

our analysis extends to more sophisticated labor-market models, where hires come from various sources. The only requirements are that vacancies reflect firms' recruiting effort, and that vacancies are related to unemployment through a Beveridge curve. The only relevant consideration for welfare is that when unemployment falls, firms allocate more resources to recruitment.

Finally, we assume that the labor market is always on the Beveridge curve. A potential concern is that labor market dynamics outside of the Beveridge curve may be important. Indeed, in matching models, unemployment evolves through a dynamic process driven by the difference between inflows into unemployment and outflows from unemployment, so unemployment is not always on the Beveridge curve. What can allay this concern is that in the United States, the inflows and outflows are extremely large, so unemployment dynamics converges extremely quickly to the Beveridge curve. Michaillat and Saez (2021a, p. 7) show that 50% of the deviation of the US unemployment rate from the Beveridge curve evaporates within one month, and 90% within one quarter. Thus, the US unemployment rate is always near the Beveridge curve. This explains why many matching models assume that the Beveridge curve holds at all times, as we do here (Hall 2005; Pissarides 2009; Landais, Michaillat, and Saez 2018b; Michaillat 2024).

II.F. Full-employment criterion

Using the social product of employed and unemployed labor and the shape of the Beveridge curve, we now formally describe and solve the social planner's problem. The solution to the planner's problem will give us the full-employment criterion based on unemployment and vacancy rates.

The planner aims to maximize social output by minimizing the sum of the unemployment and vacancy rates, $u + v$. Indeed, since unemployment and recruiting are socially wasteful, and the labor force is given, maximizing social output is tantamount to minimizing labor in unemployment or recruiting. And since the number of recruiters can be counted by the number of vacancies, the objective is to minimize the number of jobseekers plus vacancies. Equivalently, the labor-force size being fixed, the objective is to minimize the unemployment rate plus the vacancy rate.

This minimization is subject to the Beveridge curve constraint, $uv = A$. Because of the Beveridge curve, it is not possible to reduce unemployment and vacancies at the same time, so the planner must trade off unemployment and vacancies. The planner takes the Beveridge curve as given because the Beveridge curve does not seem to respond to monetary or fiscal stabilization policy. Indeed, in many business-cycle models with unemployment, the Beveridge curve is unaffected by monetary and fiscal policy (Blanchard and Gali 2010; Ravenna and Walsh 2011; Michaillat 2014; Michaillat and Saez 2019, 2022, 2024a). In these models the Beveridge curve is determined by the matching function and job-separation rate. Neither responds to monetary or fiscal policy, so the Beveridge curve is unaffected by policy.[12]

The planner minimizes nonproduction $u+v$ subject to the Beveridge curve $uv = A$, with $u \in [0,1]$ and $v \in [0,1]$. To simplify the problem, we substitute the Beveridge curve, $v = A/u$, into the objective function. Then the problem simply is to minimize $u+A/u$ over $u \in [A,1]$.[13] The function $u \mapsto u+A/u$, defined over the interval $[A,1]$, is continuous and strictly convex.[14] Therefore, the function admits a unique minimum on $[A,1]$.

As we have just seen, the minimization of $u+v$ subject to $uv = A$, with $[u,v] \in [0,1]^2$ admits a unique solution. In addition, the minimization problem is perfectly symmetric in u and v. Therefore, the minimum must be reached when $u = v$. To see why, imagine that the minimum was reached for $u = u_0$ and $v = v_0$ with $u_0 \neq v_0$. Then, because of the symmetry of the problem, setting the unemployment and vacancy rates to $u = v_0$ and $v = u_0$ would also minimize the objective function while respecting all the constraints. So the solution to the minimization problem would not be unique. We reach a contradiction here, which means that it cannot be that $u_0 \neq v_0$.

That is, full employment prevails when the unemployment and vacancy rates are equal ($u = v$). When they are not equal, the labor market is operating inefficiently. The labor market is inefficiently tight when there are more vacancies than jobseekers ($v > u$). In that case, increasing u and reducing v would increase social output. The labor market is inefficiently slack when there are more jobseekers than vacancies ($u > v$). Then, reducing u and increasing v would increase social output.

We can also solve the planner's problem by first-order condition. Recall that the planner aims to minimize $u+A/u$ over $u \in [A,1]$. Since the function $u \mapsto u+A/u$ is strictly convex, the first-order condition is sufficient to find the function's minimum over the interval $[A,1]$. We take the function's derivative with respect to u and set it to 0. We obtain $1 - A/u^2 = 0$, or equivalently $u = \sqrt{A}$. We verify that $\sqrt{A} \in [A,1]$, because $0 < A < 1$. Therefore, the function's minimum occurs when $u = \sqrt{A}$. By the Beveridge curve we have $v = A/u$, so at the minimum $v = A/\sqrt{A} = \sqrt{A}$.[15] Accordingly, at full

[12]Other policies do influence the Beveridge curve. For example, reducing unemployment insurance bolsters jobseekers' search efforts, which shifts the Beveridge curve inward (Landais, Michaillat, and Saez 2018b; Hochmuth and others 2021). The effect of such policies on welfare can be split into two components (Landais, Michaillat, and Saez 2018a). The first component is the direct effect on welfare, assuming labor-market tightness remains fixed. This includes the costs and benefits associated with shifting the Beveridge curve. The second component is the effect on welfare through tightness, which is the product of the effect of tightness on welfare (holding the policy constant) and the effect of the policy on tightness. The effect of tightness on welfare holds the policy constant, so it leaves the Beveridge curve unchanged, and it can be computed just as the effect of unemployment on welfare in this paper. Consequently, the unemployment and tightness gaps derived here remain central to optimal policy design, though they might need to be supplemented by additional elements specific to the policy in question.

[13]With $u \in [A,1]$, we ensure that $v = A/u$ is in $[0,1]$. In fact, $v \in [A,1]$, just like u.

[14]To see that the function is strictly convex, note that its second derivative is strictly positive: $2A/u^3 > 0$ for any $u > 0$.

[15]Technically, because the number of jobseekers and recruiters cannot exceed the number of labor-force participants, the planner's problem should include the constraint $u+v \leq 1$. But the constraint is satisfied at the minimum, so it does not alter the problem's solution. Indeed, we have $A < 1/4$, so $\sqrt{A} < 1/2$, which implies that at the minimum, $u+v = 2 \times \sqrt{A} < 1$.

employment, the unemployment and vacancy rates are equal and satisfy

$$u^* = v^* = \sqrt{A}. \tag{1}$$

Equation (1) shows that full employment occurs when unemployment and vacancy rates are equal. The equation also shows that the location of the Beveridge curve, A, solely determines these rates at full employment. This location summarizes everything we need to know for our welfare analysis—it is serves as the key sufficient statistic (Chetty 2009). In basic matching models the Beveridge curve's position is determined by the job-separation rate and the efficacy of the matching function. Any change in either parameter shifts the curve, affecting the FERU. However, which parameter causes the shift is irrelevant; only the shift itself matters for welfare.

We have expressed the full-employment criterion in terms of two separate variables: unemployment rate u and vacancy rate v. But we can reformulate the full-employment criterion in terms of one single variable: labor-market tightness v/u. Tightness represents the number of vacancies per jobseeker. It is a core variable in matching models of the labor market (Pissarides 2000; Shimer 2005; Hall 2005; Michaillat 2012). We have seen that the economy is at full employment when $v = u$, so it is at full employment when tightness equals 1. The economy is inefficiently tight when $v > u$, so when tightness exceeds 1. Finally, the economy is inefficiently slack when $v < u$, so when tightness falls below 1.

II.G. FERU formula

Although we have established that tightness at full employment is 1, it is still useful to construct the rate of unemployment at full unemployment—the FERU. This is because researchers and policymakers more commonly think about unemployment than about tightness, and because the effects of stabilization policies on unemployment are better understood than those on tightness (Ramey 2013, 2016).

To derive an expression for the FERU, we start from equation (1) and substitute A out of it by using the Beveridge curve $A = uv$. We find that the FERU is the geometric average of the unemployment and vacancy rates:

$$u^* = \sqrt{uv}. \tag{2}$$

Since $uv = A > 0$, expression (2) implies that the FERU is strictly positive. Hence, full employment should not be interpreted as zero unemployment.

A first reason why full employment does not mean zero unemployment is that zero unemployment is infeasible. Indeed, the Beveridge curve prevents unemployment from ever reaching zero. Because each vacancy requires a recruiter, the vacancy rate v is at most 1. Accordingly, the Beveridge curve $u = A/v$ prevents the unemployment rate to fall below $A > 0$.

The fact that labor-market flows impose a minimum level of unemployment—and therefore that full employment cannot be zero unemployment—has been known for a long time. Beveridge (1944, p. 125) realized that "however great the unsatisfied demand for labor, there is an irreducible minimum of unemployment, a margin in the labor force required to make change and movement possible." As a result, "even under full employment, there will be some unemployment,. . . on each day some men able and willing to work will not be working." Robinson (1946, pp. 169–170) made the same observation: "In a changing world there are always bound to be, at any moment, some workers who have left one job and have not yet found another.. . . Changes in occupation for personal reasons will always be going on. So long as such shifts in employment are taking place there is always likely to be some unemployment even when the general demand for labor is very high."

A second reason why full employment does not mean zero unemployment is that zero unemployment is undesirable. Unemployment is clearly a waste of economic resources as people who would like to work are not able to be productive. Yet, reducing the unemployment rate to zero is not desirable because it would require diverting a vast amount of labor toward recruiting. In fact, it is not efficient to reduce the unemployment rate below the vacancy rate. Reducing the unemployment rate by 1% requires raising the vacancy rate by 1%, due to the hyperbolic Beveridge curve. When the unemployment rate is less than the vacancy rate, the increase in vacancy rate is more than the decrease in unemployment rate. Hence, overall, although the unemployment rate falls, the sum of the unemployment and vacancy rates increases—which means that social output falls.[16]

II.H. Application to the Diamond-Mortensen-Pissarides model

We now apply our approach to the most common model of the labor market: the Diamond (1982)-Mortensen (1982)-Pissarides (1985) (DMP) model. The concept of efficiency used here is the same as in the DMP model. The model features both unemployed workers and job vacancies, each inducing output losses. More unemployment means fewer people at work so less output; more vacancies mean more labor devoted to recruiting and less output. The efficient allocation maximizes output by minimizing the combined losses from unemployment and recruiting. As the DMP model features a Beveridge curve, our results easily apply.

We consider the model presented by Pissarides (2000, chapter 1). The labor force is composed of $L > 0$ workers with linear utility function. The $1 - u$ employed workers have a productivity $p > 0$.

[16]Zero unemployment is not desirable here because of the resources absorbed by recruiting. Robinson (1946, p. 170) agreed that "no-one regards 100% employment as a desirable objective." Her logic was different, however. She argued that "the attainment of full employment, in this absolute sense, would require strict controls, including direction of labor" and that it would "involve great sacrifices of liberty," even the "complete conscription of labor."

The u unemployed workers engage in home production and their productivity is $z < p$. And firms incur a flow recruiting cost $pc > 0$ for each vacancy. Hence, flow social welfare is

$$[p(1-u) + zu - pcv]\,L.$$

We have argued that in the United States, it is accurate to set $z = 0$ and $c = 1$. Hence, flow welfare simplifies to

$$p\,[1 - (u + v)]\,L. \tag{3}$$

Maximizing flow welfare (3) is equivalent to minimizing $u + v$.

Next we turn to the Beveridge curve. The Beveridge curve is the locus of points such that labor-market flows are balanced: the number of workers who lose or quit their jobs equals the number of workers who find a job. The job-separation rate is λ, so the number of workers who lose or quit their jobs is $\lambda(1-u)$. With the standard symmetric Cobb-Douglas matching function, the number of workers who find a job is $m = \omega\sqrt{uv} = \left(\omega\sqrt{v/u}\right)u$. Along the Beveridge curve, $\lambda(1-u) = \left(\omega\sqrt{v/u}\right)u$, so the Beveridge curve satisfies

$$u = \frac{\lambda}{\lambda + \omega\sqrt{v/u}}.$$

However, in the United States the job-separation rate, λ, is more than an order of magnitude smaller than the job-finding rate, $\omega\sqrt{v/u}$ (Barnichon and Shapiro 2024, p. 10). Therefore, the Beveridge curve can be approximated by $u = \lambda/\left(\omega\sqrt{v/u}\right)$, which is a rectangular hyperbola:

$$uv = \left(\frac{\lambda}{\omega}\right)^2. \tag{4}$$

Formally, because the DMP model is dynamic, the social planner maximizes the present-discounted sum of flow social welfare, subject to the law of motion of unemployment (Pissarides 2000, pp. 183–185). To simplify, we follow Hosios (1990, p. 281) and assume that the discount rate is zero. Under this assumption, the social planner maximizes steady-state welfare. That is, the planner maximizes flow welfare (3) subject to the Beveridge curve (4). Equivalently, the planner minimizes $u + v$ subject to $uv = (\lambda/\omega)^2$. This is the exact problem studied here, so all the results apply: efficient unemployment and vacancy rates are $u^* = v^* = \sqrt{uv} = \lambda/\omega$; efficient tightness is $v^*/u^* = 1$.[17]

[17] The Hosios (1990) condition gives the bargaining power required for the market unemployment rate to coincide with the efficient unemployment rate under Nash bargaining. Instead, we determine the unemployment rate that prevails when the labor market operates efficiently.

III. FERU in the United States

We compute the FERU in the United States across three distinct periods: the standard postwar era (1951–2019), the Great Depression and World War 2 (1930–1950), and the coronavirus pandemic (2020–2024). We find that generally the US economy is not at full employment but is inefficiently slack.

III.A. Postwar period

We first focus on the postwar period, 1951–2019. This is a standard period in the macro-labor literature, for which the unemployment and vacancy data are well known and well understood (Shimer 2005, 2007; Daly and others 2012; Diamond and Sahin 2015; Michaillat and Saez 2021a). We stop at the end of 2019 to avoid incorporating the pandemic, which is an extremely unusual period that we will discuss in section III.C.

The unemployment rate (u) and vacancy rate (v) used in our analysis are displayed in figure 1. The unemployment rate is constructed by the US Bureau of Labor Statistics (2024k) from the Current Population Survey (CPS). This is the standard, official measure of unemployment, labelled U3 by the US Bureau of Labor Statistics (2023). This measure only includes jobseekers who want a job, are available to start a job, and have been actively searching for a job in the past 4 weeks.[18]

The vacancy rate is derived from two different sources because there is no continuous vacancy series over the period. For 1951–2000, we use the vacancy rate constructed by Barnichon (2010). This series is based on the Conference Board's help-wanted advertising index, adjusted to account for the shift from print advertising to online advertising in the 1990s. The Conference Board index aggregates help-wanted advertising in major metropolitan newspapers in the United States. It serves as a reliable proxy for job vacancies (Abraham 1987; Shimer 2005). For 2001–2019, we use the number of job openings measured by the US Bureau of Labor Statistics (2024f) from the JOLTS, divided by the civilian labor force constructed by the US Bureau of Labor Statistics (2024a) from the CPS.[19] We then splice the two series to create a continuous vacancy rate for 1951–2019. The two series are perfectly aligned because Barnichon (2010) used the JOLTS data to scale the Conference

[18] Section IV.C repeats the analysis with two broader measures of unemployment that include jobseekers with lower search effort: U4 and U5. These measures add to U3 people who want a job, are available to start a job, have been actively searching for a job in the past 12 months but not in the past 4 weeks.

[19] To best align vacancy and labor force data, we shift forward by one month the number of job openings from JOLTS. For instance, we assign to December 2023 the number of job openings that the BLS assigns to November 2023. The motivation for this shift is that the number of job openings from the JOLTS refers to the last business day of the month (Thursday 30 November, 2023), while the labor force from the CPS refers to the Sunday–Saturday week including the 12th of the month (Sunday 10 December 2023 to Saturday 16 December 2023) (US Bureau of Labor Statistics 2020a, 2024e). So the number of job openings refers to a day that is closer to next month's CPS reference week than to this month's CPS reference week.

Board index and translate it into a vacancy rate (which was possible because the Conference Board and JOLTS series overlap in the early 2000s).

Next we use the unemployment and vacancy rates to assess the state of the US labor market between 1951 and 2019 (figure 3A). The labor market is inefficiently slack whenever the unemployment rate is above the vacancy rate; it is inefficiently tight whenever the unemployment rate is below the vacancy rate. Over the period, the unemployment rate averages 5.8%, while the vacancy rate only averages 3.4%. So on average, the unemployment rate is markedly higher than the vacancy rate, which indicates that the labor market is inefficiently slack. In fact, the labor market is persistently inefficiently slack except in three episodes when it turns inefficiently tight: the Korean War (1951Q1–1953Q3), the Vietnam War (1965Q4–1970Q1), and the end of the Trump presidency (2018Q2–2019Q4).

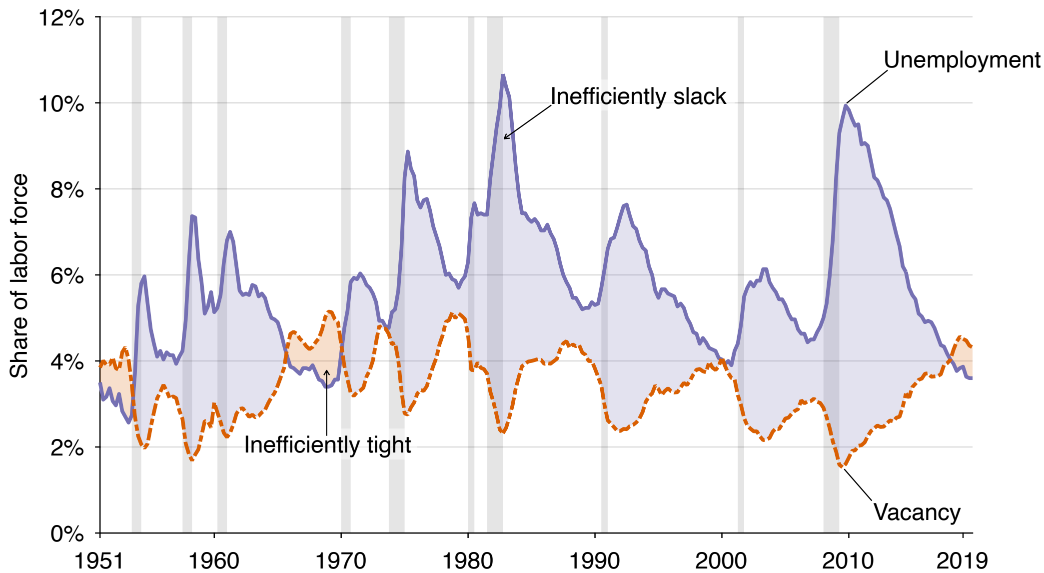
The state of the US labor market can also be visualized by plotting labor-market tightness v/u (figure 3B). The labor market is inefficiently slack whenever tightness is below 1, inefficiently tight whenever tightness is above 1, and at full employment when tightness equals 1—when there is one vacancy per jobseeker. Tightness averages 0.65 between 1951 and 2019, well below 1, which is another manifestation that the labor market is inefficiently slack on average. Tightness peaked at 1.60 in 1953Q1, during the Korean War, and it bottomed at 0.16 in 2009Q3, during the Great Recession. Twice, the labor market reached full employment just before entering a recession. This happened before the 1973–1975 recession (tightness peaked at 0.99 in 1973Q3) and before the 2001 dot-com recession (tightness peaked at 1.01 in 2000Q1).

We then compute the FERU using the formula $u^* = \sqrt{uv}$ (figure 4A). The FERU is stable: it remains between 3.1% and 5.5%, with an average value of 4.3%. The Beveridge curve shifts in and out during the postwar period (Michaillat and Saez 2021a, figure 1), but the shifts are not large enough to produce noteworthy changes in the FERU.

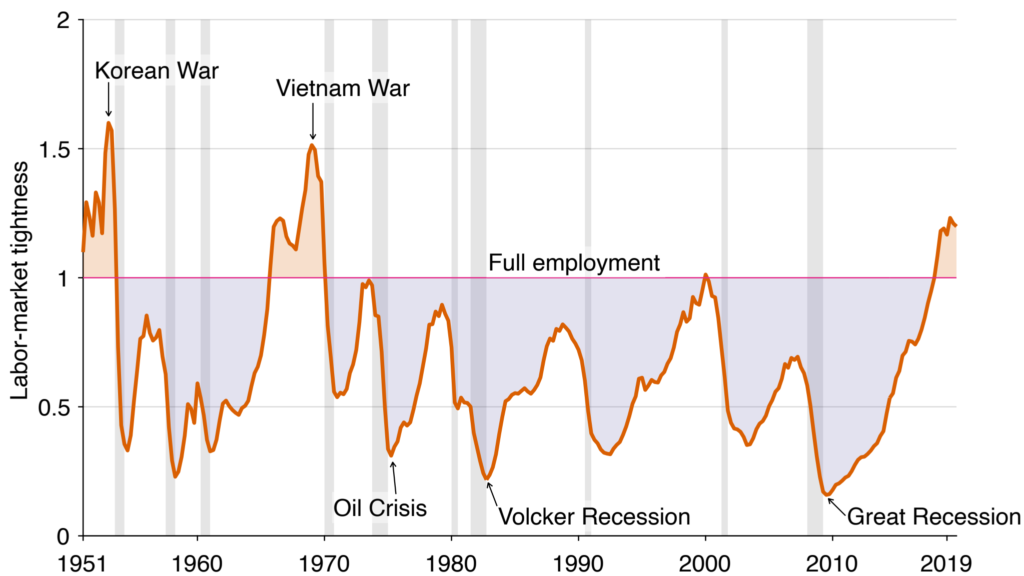
Of course what is key to design stabilization policy is not the FERU alone but the unemployment gap—the difference $u - u^*$ between unemployment rate and FERU. The unemployment gap indicates the distance from full employment at any given time. We compute the unemployment gap and find that it is generally positive and sharply countercyclical (figure 4B). The unemployment gap averages +1.5pp between 1951 and 2019. The gap peaked at +5.9pp in 2009Q4, during the Great Recession. At the end of the Volcker recession, in 1982Q4, the gap reached the slightly lower value of +5.7pp. The lowest value taken by the unemployment gap is −0.8pp, in 1969Q1, during the Vietnam War. During the Korean War, the unemployment gap was almost as low, reaching −0.7pp in 1953Q1. Hence, the economy is generally not at full employment. It is especially far from full employment in recessions.

Figure 3. Deviation from full employment in the United States, 1951Q1–2019Q4

Panel A: Visualization based on unemployment and vacancy rates



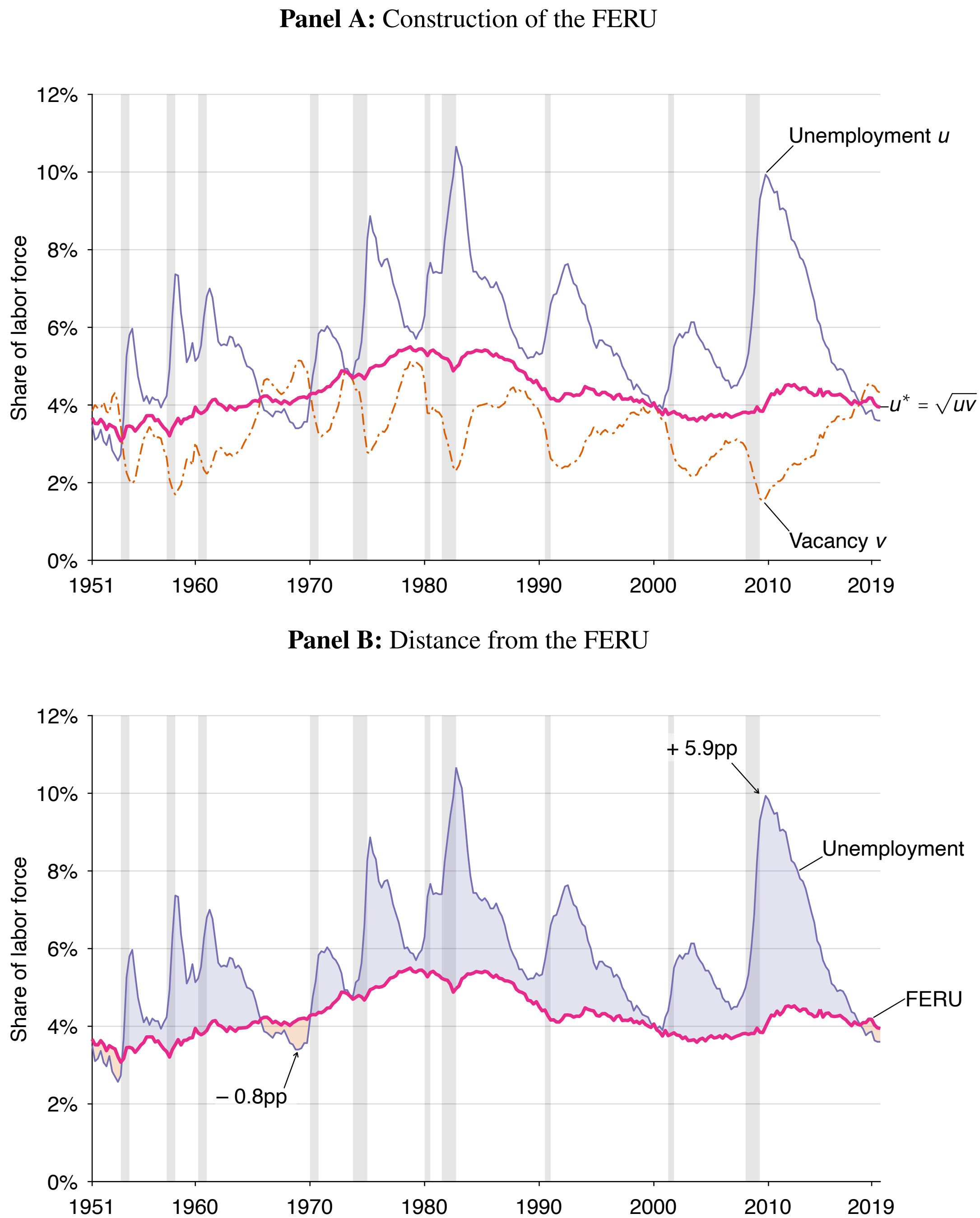
Panel B: Visualization based on labor-market tightness



Sources: Unemployment and vacancy rates come from figure 1. The gray areas are NBER-dated recessions. Labor-market tightness is the ratio of job vacancies to jobseekers.

Notes: The labor market is at full employment when the unemployment rate equals the vacancy rate, inefficiently slack when the unemployment rate exceeds the vacancy rate, and inefficiently tight when the unemployment rate is below the vacancy rate. Equivalently, the labor market is at full employment when tightness equals 1, inefficiently slack when tightness is below 1, and inefficiently tight when tightness exceeds 1.

Figure 4. FERU in the United States, 1951Q1–2019Q4



Sources: Unemployment rate u and vacancy rate v come from figure 1. The FERU (full-employment rate of unemployment) is $u^* = \sqrt{uv}$. The gray areas are NBER-dated recessions.

III.B. Great Depression and World War 2

Next, we apply our full-employment criterion and FERU formula to the period 1930–1950, which covers both the Great Depression and World War 2. Due to its simplicity, the FERU formula can easily be applied to such historical data.

The unemployment and vacancy rates for 1930–1950 are constructed by Petrosky-Nadeau and Zhang (2021). For 1930–1947, the unemployment rate is constructed by extrapolating Weir (1992)'s annual unemployment series to a monthly series using monthly unemployment rates compiled by the National Bureau of Economic Research (NBER). For 1948–1950, the unemployment rate comes from the US Bureau of Labor Statistics (2024k). The 1930–1950 vacancy rate is based on the help-wanted index created by the Metropolitan Life Insurance Company. This index aggregates help-wanted advertisements from newspapers across major US cities, and it is regarded as a reliable proxy for job vacancies (Zagorsky 1998). The MetLife index is scaled to align with Barnichon (2010)'s vacancy rate at the end of 1950, effectively translating the index into a vacancy rate.[20]

Between 1930 and 1950, it remains true that unemployment and vacancy rates move in opposite directions (figure 5A). In fact, using a logarithmic scale, it appears that unemployment and vacancy rates are inversely related (figure 5B). These fluctuations indicate that just as in the postwar era, the Beveridge curve is close to a rectangular hyperbola in 1930–1950. To confirm this observation, we compute the elasticity of the 1930–1950 Beveridge curve by running an OLS regression of log vacancy rate on log unemployment rate. We find an elasticity of -0.79, which is not far from the elasticity of -1 for a rectangular hyperbola, and is close to the elasticity of -0.84 for the 1951–1961 Beveridge curve (Michaillat and Saez 2021a, figure 6). The 1930–1950 period saw vast fluctuations in unemployment and vacancy rates: the unemployment rate fluctuated between 1.0% and 25.3%; the vacancy rate fluctuated between 0.7% and 6.7%. Yet the hyperbolic shape of the Beveridge curve held well.

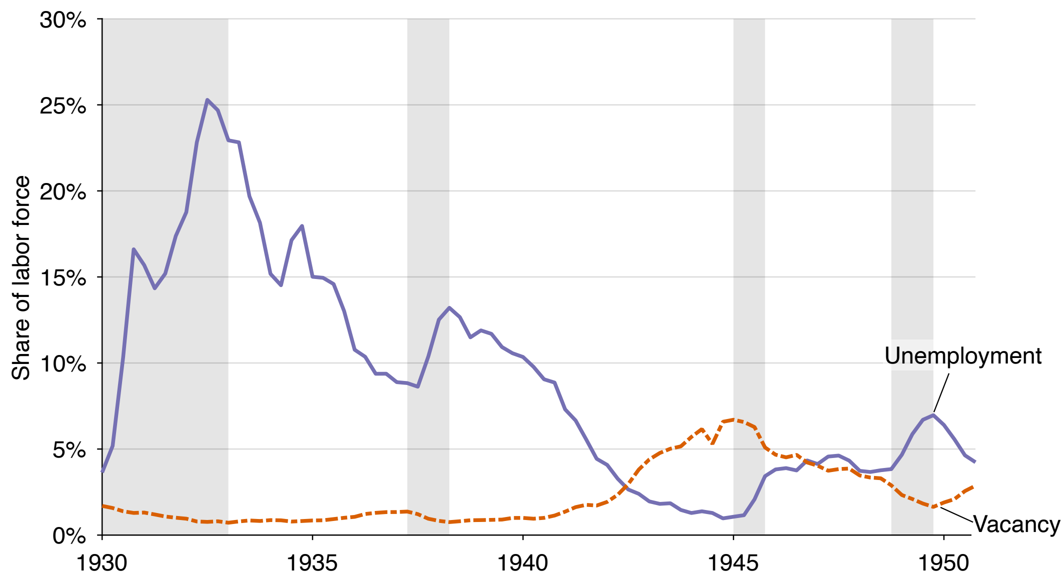
We compare the unemployment and vacancy rates to assess the state of the US labor market between 1930 and 1950 (figure 6A). The unemployment rate averages 9.0% over the period, while the vacancy rate only averages 2.3%. So on average, the unemployment rate is markedly higher than the vacancy rate, which indicates that the US labor market is inefficiently slack. In fact, the US labor market is always inefficiently slack between 1930 and 1950 except during and right after World War 2 (1942Q3–1946Q3), when it was inefficiently tight.

The state of the labor market can also be visualized by plotting labor-market tightness (figure 6B). Tightness averages $0.85 < 1$ between 1930 and 1950, which confirms that the US labor market is

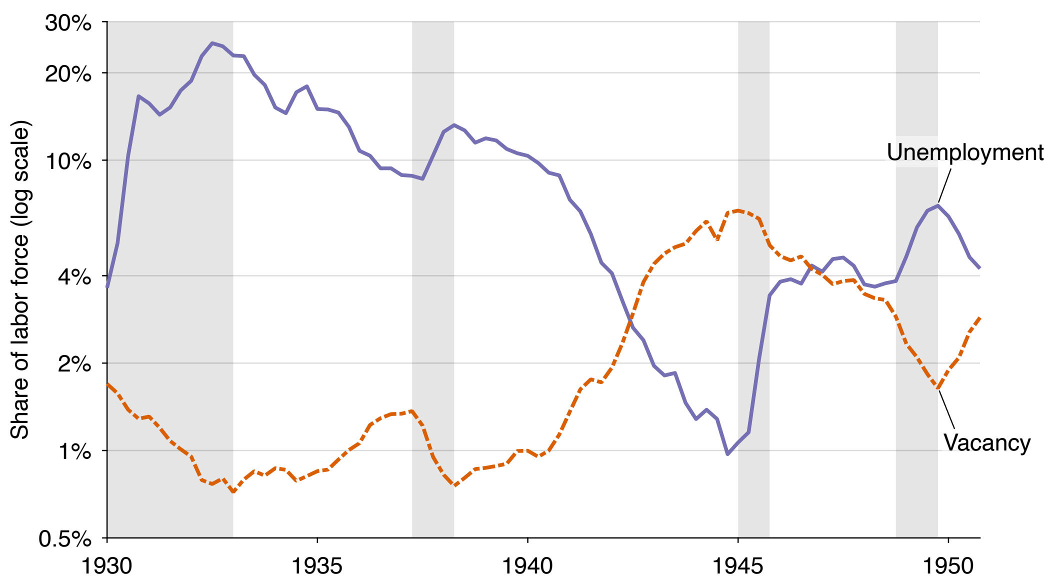
[20]Petrosky-Nadeau and Zhang (2021) produce a vacancy series that starts in 1919 and an unemployment series that starts in 1890. Zagorsky (1998, p. 339) argues, however, that the vacancy numbers are unreliable for 1919–1923, because some important newspaper data were missing during that time. Moreover, there is no monthly measure of unemployment between 1890 and 1929. Instead, the monthly unemployment fluctuations are inferred from the spread between the yields of bonds of different quality. Given these limitations, we begin our analysis in 1930.

Figure 5. Unemployment and vacancy rates in the United States, 1930Q1–1950Q4

Panel A: Linear scale



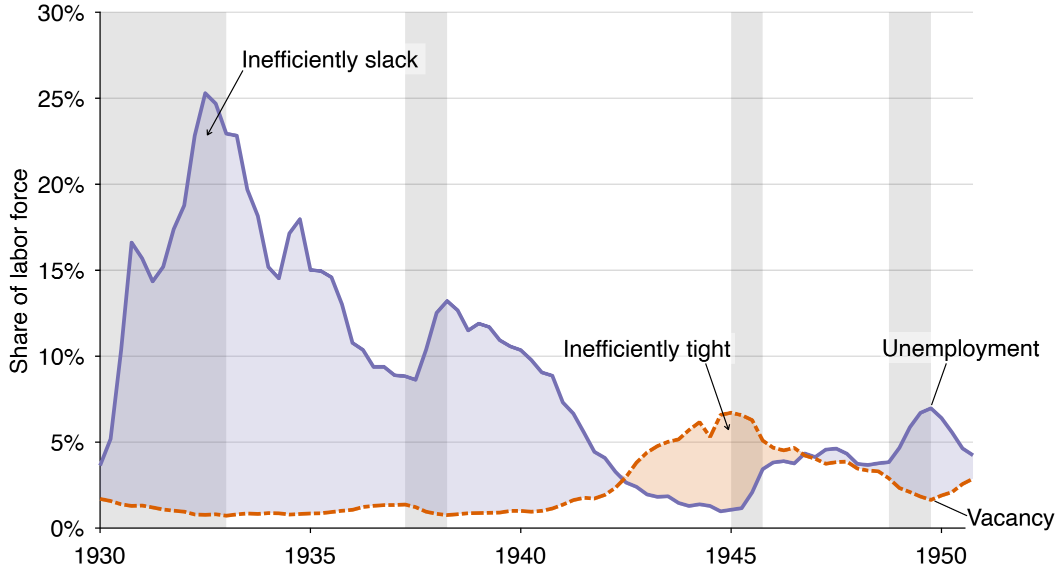
Panel B: Logarithmic scale



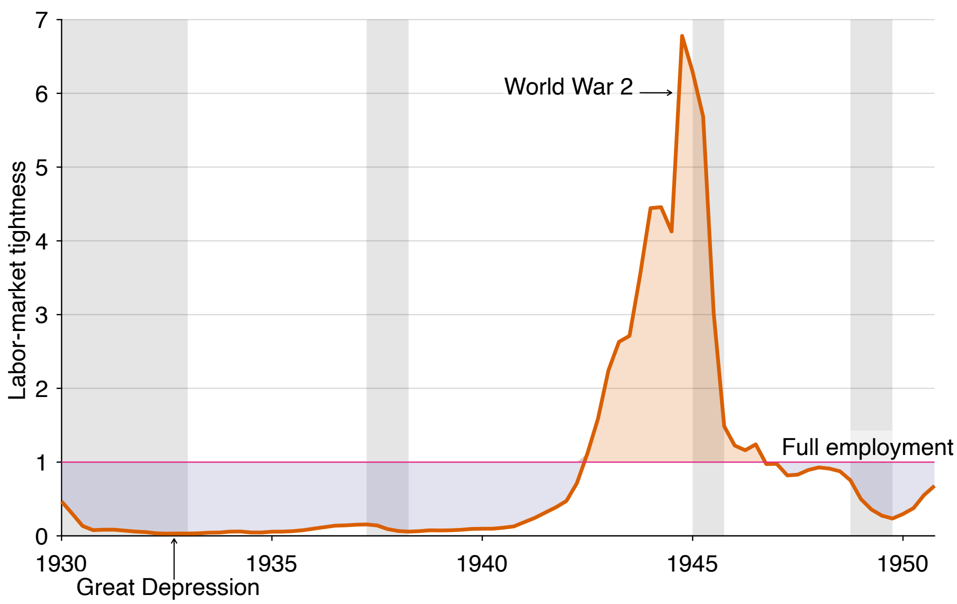
Sources: Unemployment and vacancy rates are quarterly averages of the monthly series constructed by Petrosky-Nadeau and Zhang (2021). The gray areas are NBER-dated recessions.

Figure 6. Deviation from full employment in the United States, 1930Q1–1950Q4

Panel A: Visualization based on unemployment and vacancy rates



Panel B: Visualization based on labor-market tightness

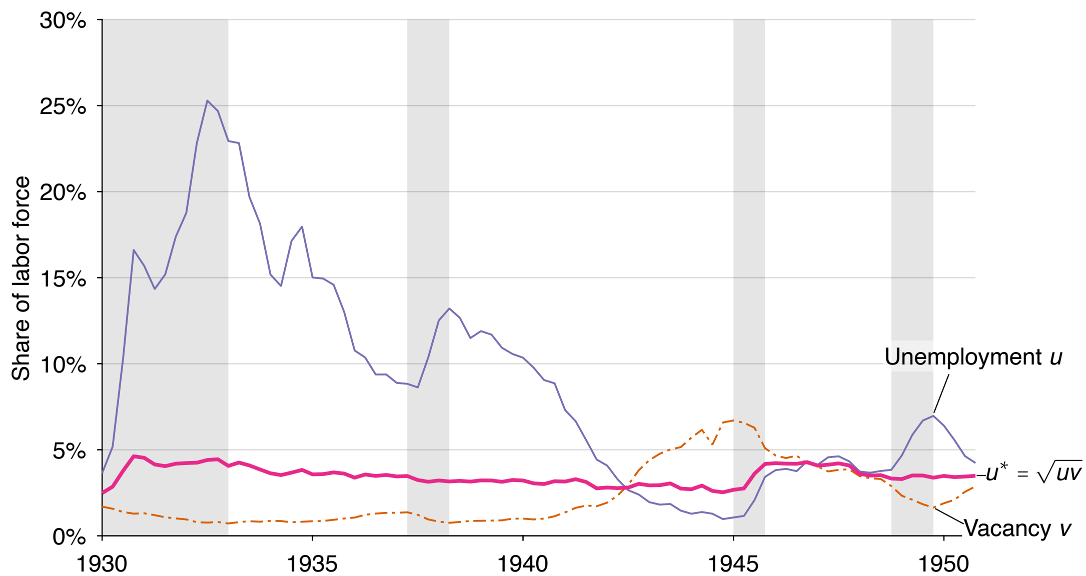


Sources: Unemployment and vacancy rates come from figure 5. Labor-market tightness is the ratio of job vacancies to jobseekers. The gray areas are NBER-dated recessions.

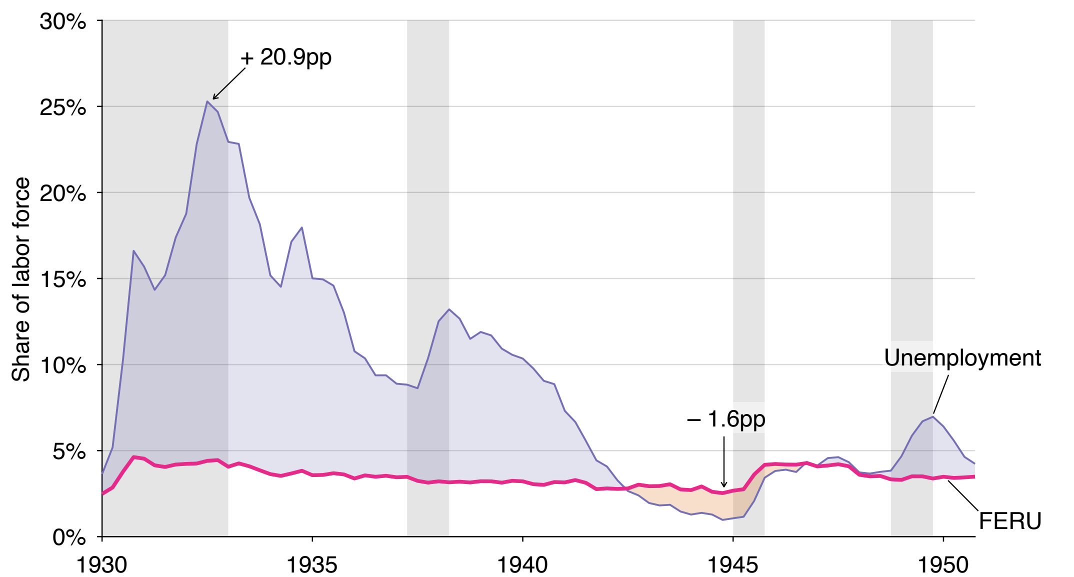
Notes: The labor market is at full employment when the unemployment rate equals the vacancy rate, inefficiently slack when the unemployment rate exceeds the vacancy rate, and inefficiently tight when the unemployment rate is below the vacancy rate. Equivalently, the labor market is at full employment when tightness equals 1, inefficiently slack when tightness is below 1, and inefficiently tight when tightness exceeds 1.

Figure 7. FERU in the United States, 1930Q1–1950Q4

Panel A: Construction of the FERU



Panel B: Distance from the FERU



Sources: Unemployment rate u and vacancy rate v come from figure 5. The FERU is $u^* = \sqrt{uv}$. The gray areas are NBER-dated recessions.

inefficiently slack on average. Tightness is extremely volatile during the period. It plunged to 0.03 in 1932Q3, during the Great Depression, and peaked at 6.8 in 1944Q4, toward the end of World War 2.

We then compute the FERU using $u^* = \sqrt{uv}$ (figure 7A). Despite significant macroeconomic volatility during the period, the FERU is stable: it remains between 2.5% and 4.6%, with an average value of 3.5%.

Finally, we compute the unemployment gap $u - u^*$ (figure 7B). The unemployment gap averages +5.5pp between 1930 and 1950. The unemployment gap was of course positive and very large during the Great Depression: the labor market was much too slack then. The unemployment gap reached +20.9pp in 1932Q3. The economy recovered only slowly from the depression. The economy reached full employment in 1942Q3, a few quarters after the United States had entered World War 2. The unemployment gap kept falling during the war; it reached −1.6pp in 1945Q1. The unemployment gap turned positive again during the 1948–1949 recession.

III.C. Coronavirus pandemic

Last, we apply our full-employment criterion and FERU formula to the coronavirus pandemic and its aftermath, from 2020Q1 to 2024Q2. Here the simplicity of the FERU formula allows us to apply it to real-time data and assess the current state of the US labor market.

The unemployment rate is measured by the US Bureau of Labor Statistics (2024k) from the CPS.[21] The vacancy rate is calculated as the number of job openings measured by the US Bureau of Labor Statistics (2024f) from the JOLTS, divided by the civilian labor force measured by the US Bureau of Labor Statistics (2024a) from the CPS.[22] Both series are displayed on figure 8A. Over 2020Q1–2024Q2, the unemployment rate averages 5.0%, and the vacancy rate averages 5.5%.

We compare the unemployment and vacancy rates to assess the state of the US labor market after the pandemic (figure 8A). Between 2020Q2 and 2021Q2, the unemployment rate exceeds the vacancy rate, so the labor market is inefficiently slack. Then, between 2021Q3 and 2024Q2, the vacancy rate surpasses the unemployment rate, so the labor market is inefficiently tight.

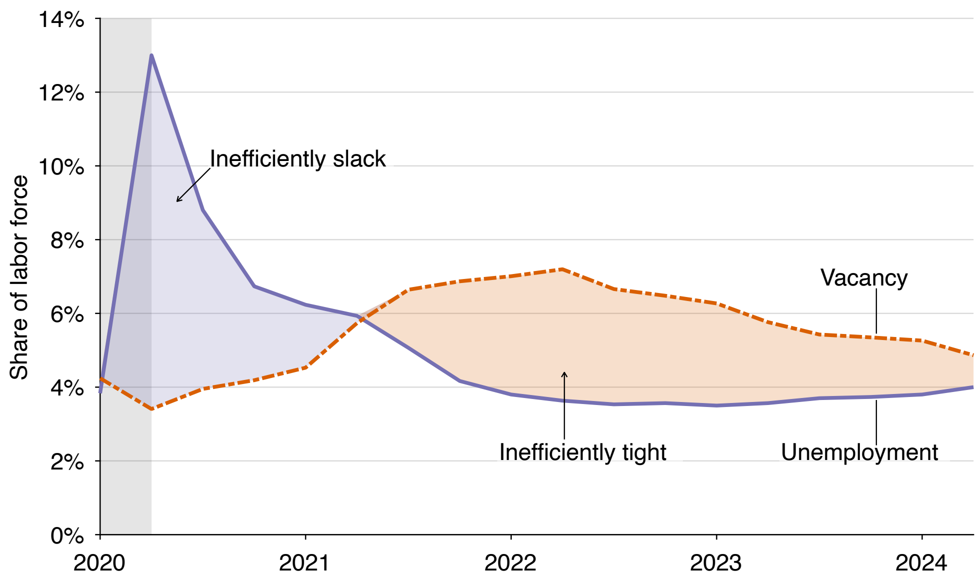
Deviations from full employment can also be visualized by plotting labor-market tightness (figure 8B). Tightness averages 1.31 between 2020Q1 and 2024Q2. Tightness cratered to 0.26 in

[21]At the start of the pandemic, many people in the CPS were misclassified as employed instead of unemployed (US Bureau of Labor Statistics 2020b). Their responses were recorded incorrectly, categorizing them as employed but absent from work when they should have been classified as unemployed on temporary layoff. This misclassification likely caused the reported unemployment rate to be lower than the true rate in March, April, and May 2020. In April and May, the true rate may have been up to 5pp higher than reported (Barnichon and Yee 2020). The error was corrected from June 2020 onward, but the BLS lacked sufficient information to adjust the earlier rates. Here we follow their approach and use the official unemployment rate, though the 2020Q2 rate may be underestimated.

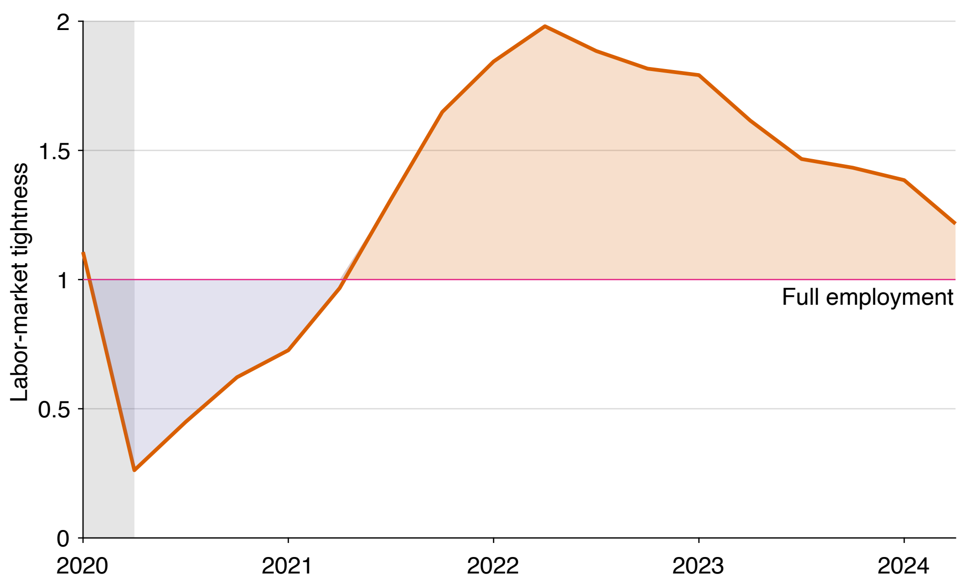
[22]The response rate to the JOLTS dropped markedly during the pandemic (US Bureau of Labor Statistics 2024d). It fell from 58% in December 2019 to 31% in September 2022. It has only recovered to 33% in April 2024. Hence, during this period, our measure of the vacancy rate might be surrounded by more uncertainty than usual.

Figure 8. Deviation from full employment in the United States, 2020Q1–2024Q2

Panel A: Visualization based on unemployment and vacancy rates



Panel B: Visualization based on labor-market tightness

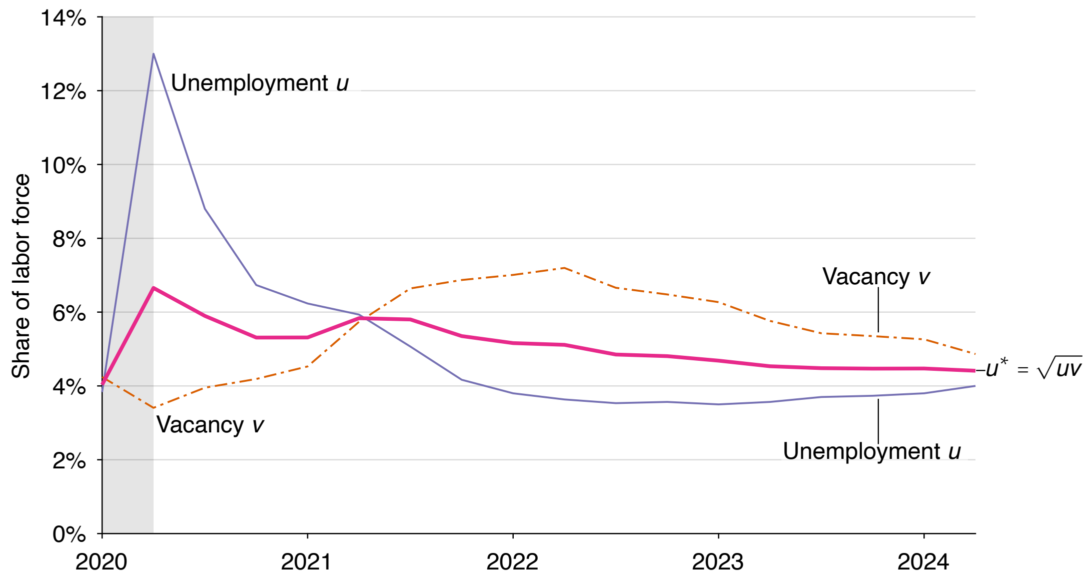


Sources: The unemployment rate is measured by the US Bureau of Labor Statistics (2024k). The vacancy rate is the number of job openings divided by the civilian labor force, both measured by the US Bureau of Labor Statistics (2024a,f). Unemployment and vacancy rates are quarterly averages of monthly series. Labor-market tightness is the ratio of job vacancies to jobseekers. The gray area is the NBER-dated pandemic recession.

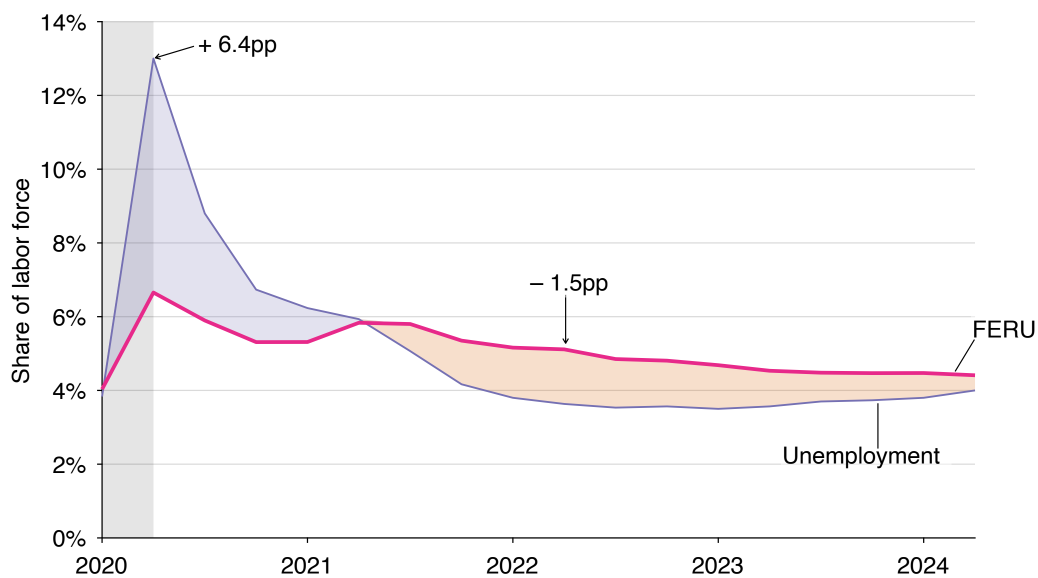
Notes: The labor market is at full employment when the unemployment rate equals the vacancy rate, inefficiently slack when the unemployment rate exceeds the vacancy rate, and inefficiently tight when the unemployment rate is below the vacancy rate. Equivalently, the labor market is at full employment when tightness equals 1, inefficiently slack when tightness is below 1, and inefficiently tight when tightness exceeds 1.

Figure 9. FERU in the United States, 2020Q1–2024Q2

Panel A: Construction of the FERU

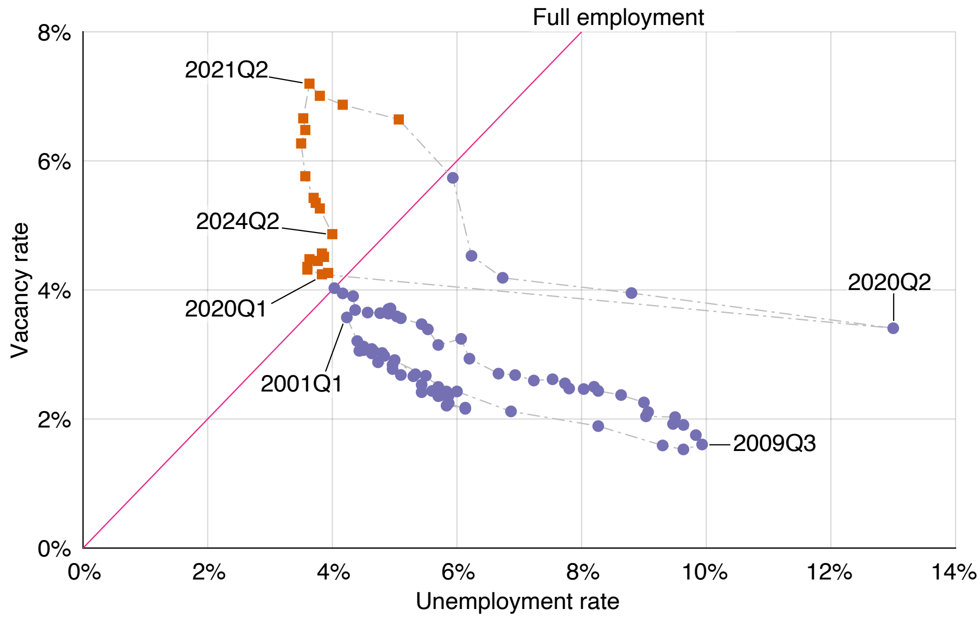


Panel B: Distance from the FERU



Sources: Unemployment rate u and vacancy rate v come from figure 8A. The FERU is $u^* = \sqrt{uv}$. The gray area is the NBER-dated pandemic recession.

Figure 10. Beveridge curve in the United States, 2001Q1–2024Q2



Sources: Each marker gives the unemployment and vacancy rates in a quarter between 2001 and 2024. The unemployment rate is measured by the US Bureau of Labor Statistics (2024k). The vacancy rate is the number of job openings divided by the civilian labor force, both measured by the US Bureau of Labor Statistics (2024a,f).

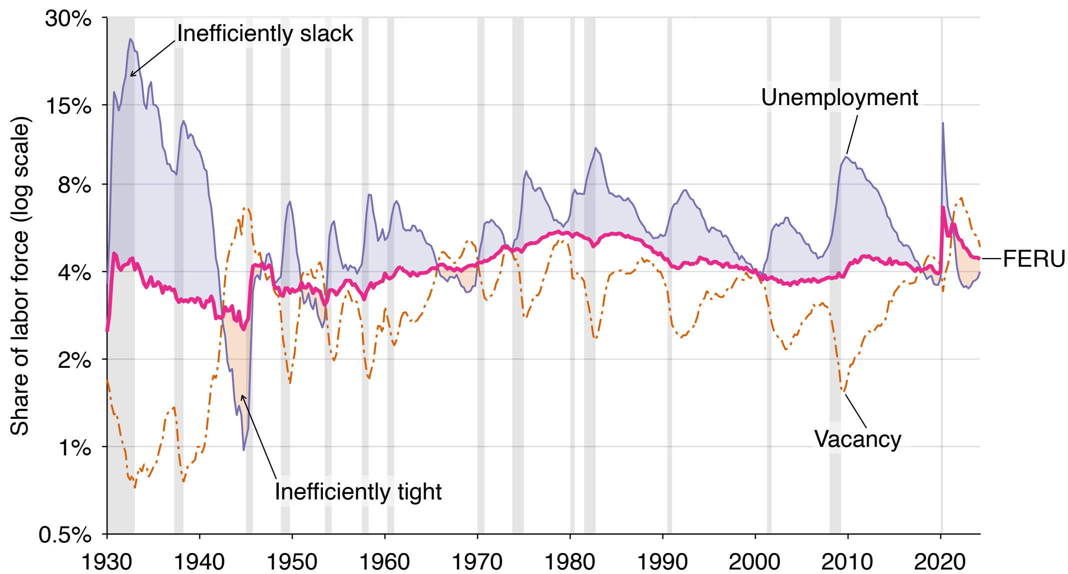
Notes: The labor market is at full employment when the unemployment rate equals the vacancy rate, inefficiently slack when the unemployment rate exceeds the vacancy rate (squares), and inefficiently tight when the vacancy rate exceeds the unemployment rate (circles).

2020Q2, so the labor market was much too slack at the beginning of the pandemic. The labor market then recovered and passed the point of full employment (tightness of 1) in the middle of 2021. Tightness then steadily rose to reach 1.98 in 2022Q2. At that point, the labor market was much too tight. After peaking in 2022Q2, tightness slowly fell down to 1.22 in 2024Q2. So in 2024 tightness has returned to its pre-pandemic level (1.23 in 2019Q2 and 1.21 in 2019Q3). While the labor market remains too tight in 2024, it is nearing full employment.

Between 2020 and 2024, the FERU averages 5.1% (figure 9A). The FERU was 4.0% in 2020Q1, at the onset of the pandemic, but it sharply increased to 6.7% in the next quarter. It hovered around 6.0% during the rest of 2020–2021, and slowly decreased to 4.4% in 2024Q2.

We also compute the unemployment gap $u - u^*$ (figure 9B). While the unemployment gap averages 0 over the period, the labor market experienced sharp departures from full employment. The unemployment gap was initially positive and large: the labor market was much too slack in the first year of the pandemic. The unemployment gap peaked at +6.3pp in 2020Q2. But the economy recovered quickly and reached full employment in the middle of 2021. The unemployment gap turned negative after that, reaching −1.5pp in 2022Q2. The gap then shrunk to −0.4pp in 2024Q2. So during 2022–2024, the labor market was well beyond full employment.

Figure 11. FERU and unemployment gap in the United States, 1930Q1–2024Q2



Sources: The unemployment rate u and vacancy rate v are obtained by splicing the unemployment and vacancy rates from figures 1, 5, and 8A. The FERU is $u^* = \sqrt{uv}$, so on a logarithmic scale it is the midpoint between the unemployment and vacancy rates. The gray areas are NBER-dated recessions.

Notes: The labor market is at full employment when the unemployment rate is equal to the FERU, or equivalently to the vacancy rate. The labor market is inefficiently slack when the unemployment rate is above the FERU, or equivalently above the vacancy rate. The labor market is inefficiently tight when the unemployment rate is below the FERU, or equivalently below the vacancy rate.

The FERU increased by almost 3pp at the onset of the pandemic (from 4.0% in 2020Q1 to 6.7% in 2020Q2). Such a sharp increase is unprecedented. It can be explained by the gigantic outward shift of the Beveridge curve that took place in the spring 2020. Graphically, the FERU appears at the intersection of the Beveridge curve and the identity line (figure 10). In 2020Q1, at the onset of the pandemic, the labor market was close to full employment, and the unemployment rate was at 3.8%. A year later, in 2021Q2, the labor market had returned to the vicinity of full employment, but the unemployment rate was now 5.9%. This rise was caused by the outward shift of the Beveridge curve that occurred in the spring of 2020. Mathematically, the FERU is determined by the location of the Beveridge curve (equation (1)), so only a sharp outward shift of the curve can raise the FERU.

III.D. Complete 1930–2024 period

To conclude, we combine the US unemployment and vacancy rates from 1930Q1 to 2024Q2. Given that the US labor market experienced extreme fluctuations during the entire period, especially in the first two decades, we plot the unemployment and vacancy rates, as well as labor-market tightness and FERU, on logarithmic scales. Beside improving the readability of the figures, logarithmic scales have several advantages. First, the symmetry of the unemployment and vacancy movements on a logarithmic scale makes it clear that the Beveridge curve is a rectangular hyperbola. Second, the FERU is particularly easy to construct on a logarithmic scale: it is just the midpoint of the unemployment and vacancy rates.[23]

A first finding is that over almost a century, the unemployment rate is generally above the vacancy rate, and this gap is exacerbated in recessions (figure 11). This means that the labor market does not generally operate at full employment. Instead, it is generally inefficiently slack, especially during recessions. Over the period, the unemployment rate averages 6.4%, whereas the vacancy rate averages only half of that, 3.2%.

The labor market is not always inefficiently slack, however. There are several episodes when it becomes inefficiently tight. And these episodes do not appear at random. Before 2018, the labor market had only been inefficiently tight during major wars—World War 2, Korean War, Vietnam War. Keynes (1936, p. 322) doubted that an economy could reach full employment in peacetime. He was essentially right: before 2018 the US economy had only reached full employment in wartime.

Since 2018, the labor market has been inefficiently tight just before the coronavirus pandemic (2018Q3–2020Q1), and in the aftermath of the pandemic (2021Q3–2024Q2). The state of the labor market around the pandemic is therefore a rarity: it is the only peacetime episode of inefficiently tight labor market in the United States.

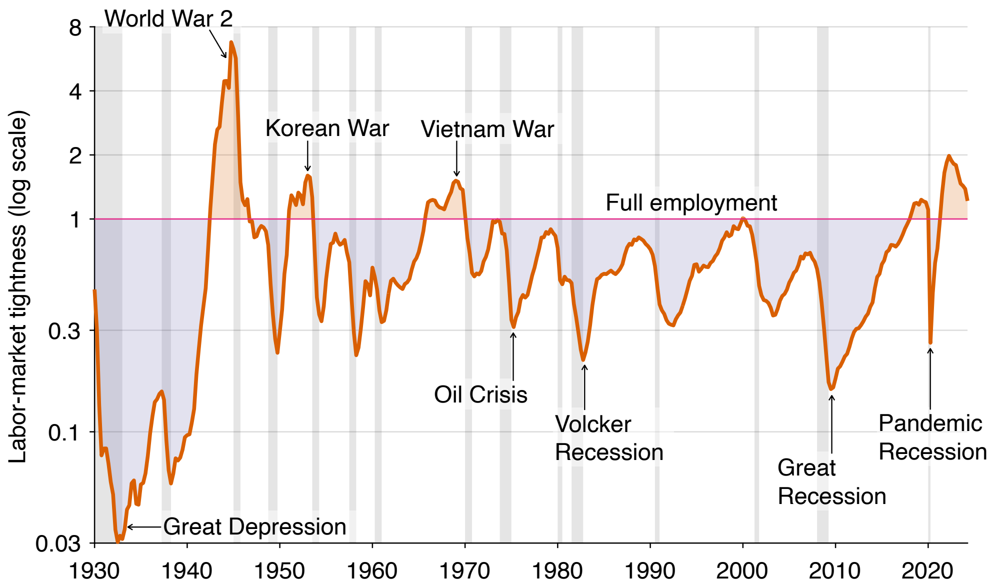
Over 1930–2024, the FERU averages 4.1% (figure 11). The FERU is stable over time, remaining between 2.5% and 6.7% over almost a century. It hovered around 4% between 1930 and 1970. It rose to about 5% in the 1970s and stayed there in the 1980s. It then remained around 4% again between 1990 and 2020. Finally, it temporarily rose above 6% during the pandemic, before falling back down below 5% after 2023.

Accordingly, over 1930–2024, the unemployment gap averages +2.3pp. The unemployment gap reached its highest level on record, +20.9pp, during the Great Depression. The unemployment gap then reached its lowest level on record, −1.6pp, at the end of World War 2. During and after the pandemic, the unemployment gap reached its highest and lowest levels since 1945. First, the unemployment gap peaked at +6.3pp in the middle of the pandemic; then, the unemployment gap fell to −1.5pp when the economy was recovering from the pandemic.

The state of the labor market can also be visualized by plotting labor-market tightness (figure 12). Over 1930–2024, labor-market tightness averages 0.73. Tightness is extremely volatile before the end of World War 2. Tightness reached its most extreme values during that period: tightness plunged to 0.03 during the Great Depression and climbed all the way to 6.8 at the end of World War 2. In the aftermath of the pandemic, the US labor market has become historically tight. In 2022Q2, tightness reached 1.98, a value which it had last reached in 1945.

[23] Since $u^* = \sqrt{uv}$, then $\ln(u^*) = (\ln(u) + \ln(v))/2$.

Figure 12. Labor-market tightness in the United States, 1930Q1–2024Q2



Sources: Labor-market tightness v/u is obtained by splicing labor-market tightnesses from figures 3B, 6B, and 8B. The gray areas are NBER-dated recessions.

Notes: The labor market is at full employment when tightness equals 1, inefficiently slack when tightness is below 1, and inefficiently tight when tightness exceeds 1.

IV. Robustness of the US FERU

This section demonstrates that the value of the FERU computed in section III is robust to an endogenous labor force, alternative calibrations of the model parameters, and alternative measures of unemployment.

IV.A. Endogenous labor force

We derive the formula $u^* = \sqrt{uv}$ by assuming that the labor force is exogenous. This assumption is motivated by evidence that labor-force participation in the United States is acyclical. The formula continues to hold, however, if we endogenize labor-force participation and allow it to be cyclical.

We normalize the size of the population to 1, and we denote the size of the labor force by $h \in (0, 1)$. Each person $i \in [0, 1]$ has linear utility over consumption $c(i)$. If they do not participate in the labor force, they enjoy utility ηi^{ϕ}. The parameter $\eta > 0$ governs the utility from nonparticipation relative to consumption. The parameter $\phi \geq 0$ ensures that the utility from nonparticipation is increasing in i. People with high i enjoy nonparticipation very much. The utility from nonparticipation may come from home production or recreation.

People's only decision is whether to participate in the labor force or not. If person i refuses to participate, she gets utility ηi^{ϕ}. If she decides to participate, she receives utility from her expected labor income $(1-u)w$, where $(1-u)$ is the probability to find a job, and w is the real wage that she receives if she finds a job. We assume that unemployed workers do not receive any income, but the analysis would be unchanged if they received unemployment benefits.[24]

The participation decision is simple. Anyone with sufficiently high utility from nonparticipation relative to the expected labor income remain outside the labor force. Anyone with sufficiently low enough utility from nonparticipation participates. Formally, people opt to participate when $\eta i^{\phi} \leq (1-u)w$, and they refuse to participate when $\eta i^{\phi} > (1-u)w$. Accordingly, the size of the labor force is implicitly defined by

$$\eta h^{\phi} = (1-u)w. \tag{5}$$

This equation says that the marginal labor-force participant ($i = h$) is indifferent between participating and not, because her nonparticipation utility (ηh^{ϕ}) equals the expected labor income ($(1-u)w$).

Next, we compute the real wage w. We assume that firms have linear production functions and normalize labor productivity to 1. In aggregate, firms employ $(1-u)h$ workers, and among those, $(1-u-v)h$ are producers and vh are recruiters. So firms produce $(1-u-v)h$ goods and services. On the other hand, the aggregate real wage bill is $w(1-u)h$. Under the usual assumption that firms make no profits because of free entry, the aggregate production and real wage bill must be equal, so

$$w = \frac{1-u-v}{1-u}. \tag{6}$$

Notice that $w < 1$: producers are paid strictly less than their marginal product. This is a standard result in matching models: firms make some profits on producers to cover recruiting costs.

Combining equations (5) and (6), we find that the labor-force participation rate is an implicit function $h(u)$ of the unemployment rate:

$$h(u) = \left[\frac{1-u-v(u)}{\eta}\right]^{1/\phi}. \tag{7}$$

The participation rate depends solely on the unemployment rate. This is because the unemployment

[24] Assume that the government provides unemployment benefits b to all jobseekers, and that the benefits are financed by a payroll tax t levied on all employees. Then the income of the $(1-u)h$ employees becomes $(1-t)w$ while the income of the uh jobseekers becomes b. The expected income from participating therefore becomes $(1-u)(1-t)w + ub = (1-u)w + [ub - (1-u)tw]$. Since the unemployment insurance's budget must be balanced, the income provided to jobseekers through unemployment benefits, buh, must equal the income taken away from employees through payroll taxes, $tw(1-u)h$. The budget constraint requires $ub - (1-u)tw = 0$, so the expected income from participation is unchanged at $(1-u)w$.

rate determines the job-finding probability $(1 - u)$ and real wage (equation (6)) and thus the expected labor income.

We now turn to the welfare function in this generalized framework. Social welfare is just the sum of individual utilities:

$$\mathcal{W} = \int_0^1 c(i)di + \int_h^1 \eta i^{\phi} di.$$

The first term is social welfare from consumption, which is just aggregate consumption, $[1 - u - v(u)]h(u)$. The second term is social welfare from nonparticipation for everyone who decides to stay out of the labor force. Hence social welfare is a function of the unemployment rate:

$$\mathcal{W}(u) = [1 - u - v(u)]\, h(u) + \int_{h(u)}^1 \eta i^{\phi} di.$$

The social planner chooses the unemployment rate u to maximize welfare $\mathcal{W}(u)$. Using Leibniz's rule, we compute the first-order condition for the maximization problem:

$$0 = \mathcal{W}'(u) = \left[-1 - v'(u)\right] h(u) + h'(u) \left[1 - (u + v) - \eta h(u)^{\phi}\right].$$

Critically, we learn from (7) that $\eta h(u)^{\phi} = 1 - (u + v)$, so the second term in the equation is 0. Therefore, the first-order condition reduces to $v'(u) = -1$, just as in the baseline case with fixed labor force. Since the Beveridge curve is a rectangular hyperbola, $v'(u) = -v/u$, and we recover the result that welfare is maximized when $u = v$.

In sum, endogenizing labor-force participation does not change the analysis at all. The FERU remains given by $u^* = \sqrt{uv}$. This result stems from an envelope-theorem logic that is classic in public economics. Even if the social planner alters the labor force by changing the unemployment rate, welfare is unaffected because the workers who move in or out of the labor force are indifferent between participating or not.[25] For them, expected labor income equals utility from nonparticipation.

Our analysis also explains why the labor-force participation rate seems acyclical. At full employment, $u + v(u)$ is minimized, so the derivative of $u + v(u)$ with respect to u is zero. Equation (7) then implies that the derivative of $h(u)$ with respect to u is zero around full employment. That is, unemployment has no first-order effect on the labor-force participation rate around full employment.

Away from full employment, things are different, but no clear cyclicality emerges. When the unemployment rate is inefficiently low $(u < u^*)$, then $u + v(u)$ is decreasing in u, so that $h(u)$ is increasing in u. When the unemployment rate is inefficiently high $(u > u^*)$, the opposite occurs: $u + v(u)$ is increasing in u, so $h(u)$ is decreasing in u. Thus, the labor-force participation rate is

[25] If workers strictly preferred participation to nonparticipation, they would move into the labor force. Conversely, if they strictly preferred nonparticipation, they would move out of the labor force. Participation only requires searching for a job, so nothing prevents a willing worker to participate. This differs from employment, which requires securing a job. Thus, nonparticipation is voluntary whereas unemployment is involuntary.

countercyclical when the labor market is inefficiently tight and procyclical when the labor market is inefficiently slack.

Given that the US labor market is generally inefficiently slack, we would expect the participation rate to be mildly procyclical. However, we would expect the fluctuations to be small because at the extensive margin, labor supply is quite inelastic, which means that the Frisch elasticity of labor supply $1/\phi$ is quite small (Chetty and others 2013). Through (7), this inelasticity implies that the participation rate does not respond much to the unemployment rate.

IV.B. Alternative calibrations of the model parameters

We derive the formula $u^* = \sqrt{uv}$ by assuming that the elasticity of the Beveridge curve is -1, each vacancy requires 1 recruiter, and the social product of unemployed labor is 0. This calibration is based on evidence for the United States.

Yet, the FERU formula can also be derived using a more general calibration of the parameters (Michaillat and Saez 2021a). We now assume that the Beveridge elasticity is $-\epsilon \neq -1$, the recruiting cost is $\kappa \neq 1$, and the social product of unemployed labor is $\zeta \neq 0$. Then social output becomes

$$(1 - u - \kappa v) + \zeta u = 1 - [(1 - \zeta)u + \kappa v].$$

Hence, the social planner minimizes $(1 - \zeta)u + \kappa v$, subject to the Beveridge curve $u^{\epsilon} \cdot v = A$.

Under this general calibration, the FERU becomes

$$u^* = \left(\frac{\kappa\epsilon}{1 - \zeta} \cdot u^{\epsilon} \cdot v\right)^{1/(1+\epsilon)}, \tag{8}$$

as shown by Michaillat and Saez (2021a, proposition 3). Of course, by setting the parameters to their baseline values, $\epsilon = 1$, $\kappa = 1$, and $\zeta = 0$, formula (8) reduces to $u^* = \sqrt{uv}$.

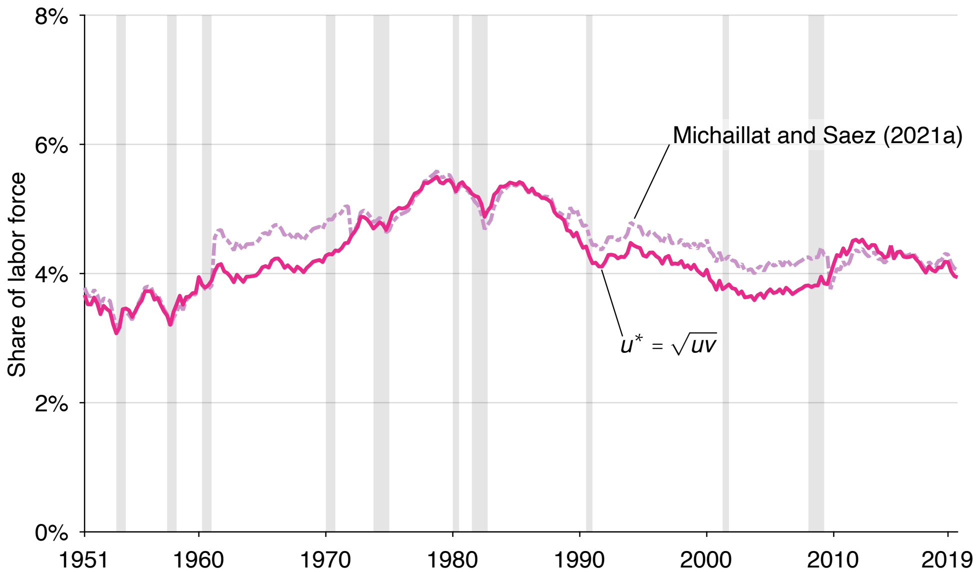
While the generalized formula is more flexible, it requires tracking three parameters $(\epsilon, \zeta, \kappa)$, so it is harder to compute than $u^* = \sqrt{uv}$. The generalized formula is especially difficult to use in real time because it requires tracking the slope of the Beveridge curve, which is difficult when the curve shifts. By setting the parameters to reasonable but fixed values, we obtain $u^* = \sqrt{uv}$, which is simpler and thus better suited to measure full employment in real time.

In the United States, however, the two formulas yield almost identical FERUs (figure 13A). Following Michaillat and Saez (2021a, figure 7B), we apply formula (8) with the Beveridge elasticity $-\epsilon$ estimated by Michaillat and Saez (2021a, figure 6), a recruiting cost $\kappa = 0.92$, and a social product of unemployed labor $\zeta = 0.26$. Between 1951 and 2019, that FERU only differs from $u^* = \sqrt{uv}$ by 0.2pp on average; they never differ by more than 0.6pp.

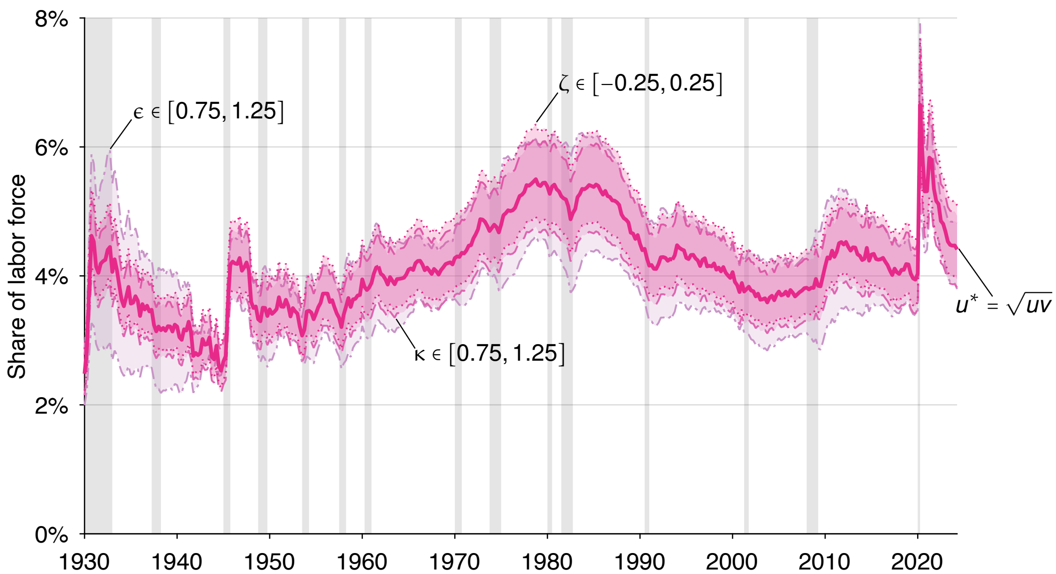
Naturally, there is some uncertainty about the true values of the parameters ϵ, κ, ζ. However,

Figure 13. US FERU under alternative calibrations of the model parameters

Panel A: Comparison with the FERU from Michaillat and Saez (2021a), 1951Q1–2019Q4



Panel B: Sensitivity of the FERU to alternative calibrations, 1930Q1–2024Q2



Sources: Panel A: The solid line is the FERU from figure 11. The dotted line is the FERU from Michaillat and Saez (2021a, figure 7B), which is obtained from formula (8) with the Beveridge elasticity $-\epsilon$ estimated by Michaillat and Saez (2021a, figure 6), the recruiting cost $\kappa = 0.92$, and the social product of unemployed labor $\zeta = 0.26$. Panel B: The solid line is the FERU from figure 11. The area between the dot-dashed lines represents the FERUs obtained from formula (8) with $\epsilon \in [0.75, 1.25]$, $\kappa = 1$, and $\zeta = 0$. The area between the dashed lines represents the FERUs obtained from formula (8) with $\epsilon = 1$, $\kappa \in [0.75, 1.25]$, and $\zeta = 0$. The area between the dotted lines represents the FERUs obtained from formula (8) with $\epsilon = 1$, $\kappa = 1$, and $\zeta \in [-0.25, 0.25]$. The gray areas are NBER-dated recessions.

the FERU produced by the generalized formula is fairly insensitive to these values. To demonstrate this, we compute the FERUs given by formula (8) when the parameters range from 25% below to 25% above their baseline values (figure 13B). Specifically, the Beveridge elasticity $-\epsilon$ ranges from -1.25 to -0.75, the recruiting cost κ ranges from 0.75 to 1.25, and the social product of unemployed labor ζ ranges from -0.25 to 0.25.[26] Between 1930Q1 and 2024Q2, the average width of the FERU band generated by $\epsilon \in [0.75, 1.25]$, $\kappa = 1$, and $\zeta = 0$ is 1.4pp. The average width of the FERU band generated by $\kappa \in [0.75, 1.25]$, $\epsilon = 1$, and $\zeta = 0$ is 1.0pp. And the average width of the FERU band generated by $\zeta \in [-0.25, 0.25]$, $\epsilon = 1$, and $\kappa = 1$ is 1.1pp. Thus, all the FERUs remain close to the baseline value, located at the center of the band. For example, in 2024Q2, the baseline FERU is 4.4%, while the FERUs are 3.8%for $\epsilon = 0.75$, 3.8% for $\kappa = 0.75$, 3.9% for $\zeta = -0.25$, 4.8% for $\epsilon = 1.25$, 4.9% for $\kappa = 1.25$, and 5.1% for $\zeta = 0.25$.

Overall, the value of the FERU in the United States is robust to a broad range of parameter calibrations. Nevertheless, to measure the FERU in other countries accurately, it might be necessary to use the generalized formula and adjust the calibration of the parameters. This is because the parameters might not take the same values abroad as in the US economy. The shape of the Beveridge curve is particularly likely to be different (Gaddnas and Keranen 2023, table 1).

IV.C. Alternative measures of unemployment

When we apply the FERU formula to the US economy in section III, we stick to the official definition of unemployment. Here we recompute the FERU using broader definitions of unemployment—replacing the unemployment rate U3 by the broader unemployment rates U4 and U5, and adjusting the size of the labor force accordingly. To clarify that our baseline measures of u and v are based on the concept U3 of unemployment, we denote them by $u3$ and $v3$ here.

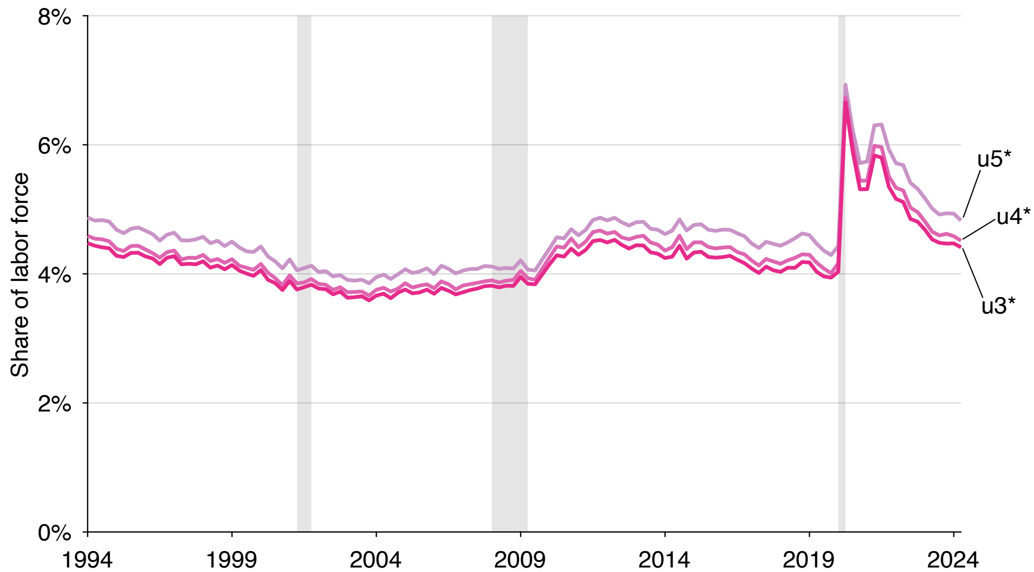
Unemployment comprises people able, willing, and seeking to work. The empirical challenge is to determine who is seeking a job. People search with different intensity and methods. Ideally anyone searching in any way would be counted as unemployed. However, the standard unemployment rate U3 only count as unemployed people who have been actively searching in the past 4 weeks. There are workers who have been searching for a job in the past year but not in the past month who are not counted as unemployed, although in theory they belong there.

The unemployment concept U4 includes all the workers in the standard unemployment concept U3, plus workers who want a job, are available to start a job now, have been actively searching for a job in the past 12 months, but have not been searching in the past 4 weeks because they became discouraged about their job prospects (US Bureau of Labor Statistics 2023). When asked why they did not look for work during the last 4 weeks, these workers respond for instance that "There are no

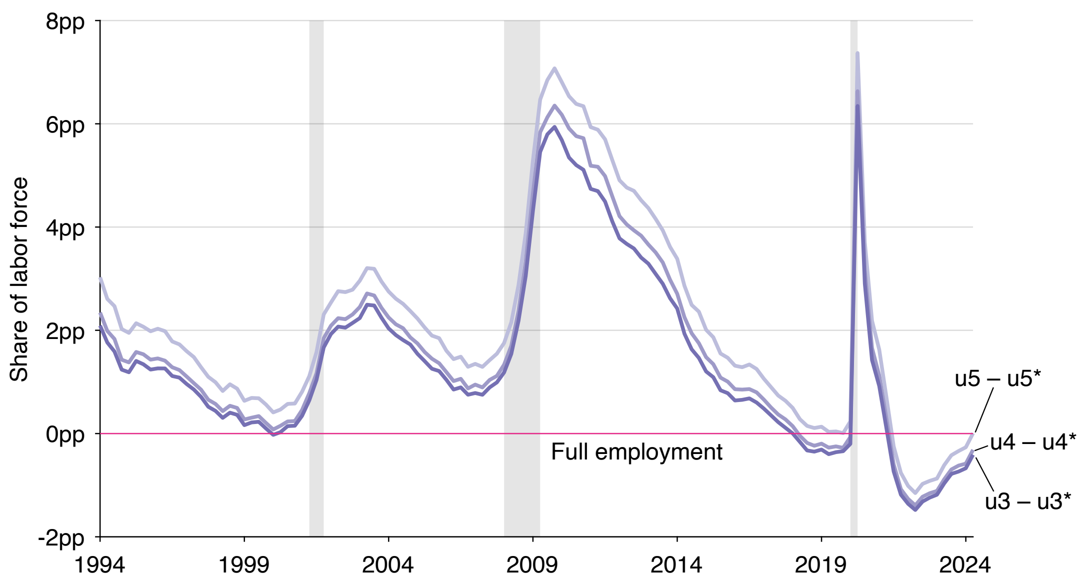
[26]In formula (8), the relevant statistic is the social product of employed labor relative to unemployed labor, $1-\zeta$, rather than ζ directly. For $1-\zeta$ to range from 0.75 to 1.25, ζ must range from -0.25 to 0.25.

Figure 14. US FERU under alternative measures of unemployment, 1994Q1–2024Q2

Panel A: Alternative FERUs



Panel B: Alternative unemployment gaps



Sources: The FERUs are given by $u3^* = \sqrt{u3 \times v3}$, $u4^* = \sqrt{u4 \times v4}$, and $u5^* = \sqrt{u5 \times v5}$. The unemployment rates $u3$, $u4$, and $u5$ are measured by the US Bureau of Labor Statistics (2024k,i,j). The vacancy level comes from figure 11. The vacancy rate $v3$ is the vacancy level divided by the number of labor-force participants, measured by the US Bureau of Labor Statistics (2024a). The vacancy rate $v4$ is the vacancy level divided by the number of labor-force participants and discouraged workers, both measured by the US Bureau of Labor Statistics (2024a,g). The vacancy rate $v5$ is the vacancy level divided by the number of labor-force participants and marginally attached workers, both measured by the US Bureau of Labor Statistics (2024a,h). Unemployment and vacancy rates are quarterly averages of monthly series. The gray areas are NBER-dated recessions.

jobs available," or "They have been unable to find work in the past." These additional workers are labelled discouraged workers. They are not counted in U3 because they did not actively search for work in the last 4 weeks.

The unemployment concept U5 includes all the workers in U4 plus workers who want a job, are available to start a job now, have been actively searching for a job in the past 12 months, but have not been searching in the past 4 weeks for other reasons than discouragement about their job prospects (US Bureau of Labor Statistics 2023). When asked why they did not look for work during the last 4 weeks, these workers respond for instance that they could not search because of family responsibilities, childcare problems, or ill health. These additional workers are not classified in U3 because they did not actively search for work in the last 4 weeks; they are not classified in U4 because they were not discouraged about their job prospects. Together with the discouraged workers, these workers compose the marginally attached workers.

To be consistent with the concepts U4 and U5 of unemployment, we introduce two broader labor-force sizes, which we use to compute unemployment and vacancy rates consistent with the U4 and U5 concepts. The unemployment rate $u4$, constructed by the US Bureau of Labor Statistics (2024i), is the unemployment level U4 divided by a broader labor force made of the standard labor force plus discouraged workers, both measured by the US Bureau of Labor Statistics (2024a,g). We construct the vacancy rate $v4$ as the vacancy level from figure 11 divided by this broader labor force. In that way, the rates $u4$ and $v4$ have the same denominator. Similarly, the unemployment rate $u5$, constructed by the US Bureau of Labor Statistics (2024j), is the unemployment level U5 divided by an even broader labor force, made of the standard labor force plus marginally attached workers, both measured by the US Bureau of Labor Statistics (2024a,h). We construct the vacancy rate $v5$ as the vacancy level from figure 11 divided by this even broader standard labor force. The unemployment concepts U4 and U5 were only introduced in 1994, so we can only measure $u4$, $v4$, $u5$, $v5$ for 1994Q1–2024Q2.

Over 1994–2024, the standard unemployment rate, $u3$, averages 5.6%. By comparison, $u4$ averages 5.9% and $u5$ averages 6.7%. So the discouraged workers make up less than 0.5% of the labor force, and the marginally attached workers make up about 1% of the labor force. All the vacancy rates are extremely close, averaging 3.4% over the period.

Using these broader measures of unemployment, we construct broader measures of the FERU: $u4^* = \sqrt{u4 \times v4}$ and $u5^* = \sqrt{u5 \times v5}$ (figure 14A). We compare these measures to the standard FERU: $u3^* = \sqrt{u3 \times v3}$. Between 1994Q1 and 2024Q2, $u3^*$ averages 4.2%, $u4^*$ averages 4.3%, and $u5^*$ averages 4.6%. So the three FERU measures are close to each other—much closer in fact than the three measures of unemployment. We also see that all three measures follow the same patterns: the largest distance between $u3^*$ and $u4^*$ is only 0.2pp and the largest distance between $u3^*$ and $u5^*$ is only 0.6pp.

We also construct broader measures of the unemployment gap: $u4 - u4^*$ and $u5 - u5^*$ (figure 14B). The three unemployment gaps all move together. But the unemployment gaps constructed with the concepts U4 and U5 of unemployment are larger than the baseline unemployment gap, because the unemployment rates $u4$ and $u5$ are larger than $u3$. Over the 1994–2024 period, the gap $u3 - u3^*$ averages +1.4pp, the gap $u4 - u4^*$ averages +1.6pp, and the gap $u5 - u5^*$ averages +2.1pp. Under the largest unemployment gap, $u5 - u5^*$, the economy appears at full employment in 2019—and not inefficiently tight. The final readings of the unemployment gaps in 2024Q2 are $u3 - u3^* = -0.4$pp, $u4 - u4^* = -0.3$pp, and $u5 - u5^* = 0.0$pp. So in 2024, the labor market is inefficiently tight under U3 and U4, but it is back to full employment under U5.

V. Explaining deviations from full employment in the United States

Despite the US government's full-employment mandate, the US labor market has consistently fallen short of full employment in the past century. Here we attempt to explain why the US labor market has deviated from full employment in different periods.

V.A. Great Depression and its aftermath

During the Great Depression and its aftermath, the US economy was exceedingly slack. From the beginning of 1930, when our data begin, to the end of 1941, when the United States entered World War 2, the unemployment gap averages +9.6pp (figure 7B). So the US economy was extremely far from full employment.

Three factors may explain this large amount of slack. The first is that the US government and the Federal Reserve did not have a full-employment mandate at the time. The mandate was introduced with the Employment Act of 1946, as a result of the Great Depression. A second factor is that the Federal Reserve was committed to the gold standard. The gold standard generated a deep deflation in the early 1930s, with dramatic consequences (Eichengreen and Temin 2000). A third factor is that the Fed failed to curb recurrent banking panics in the 1930s (Friedman and Schwartz 1963, chapter 7). Overall, as former Fed Chair Bernanke (2022, p. xvii) writes, "Blaming the Depression entirely on the Fed is an exaggeration, but the relatively new and unseasoned central bank did perform poorly."

V.B. World War 2, Korean War, Vietnam War

The US labor market was pulled out of its Great Depression slackness by World War 2 (figure 12). In fact, the labor market became inefficiently tight during the war, with tightness averaging 2.8 over the 1942–1945 period. The labor market was once again inefficiently tight during the Korean War, with tightness averaging 1.12 over the 1951–1953 period, and during the Vietnam War, with tightness averaging 1.22 over the 1966–1969 period.

Why was tightness so high during the wars? Part of the reason is that government spending was substantial during these three major wars (Ramey and Shapiro 1998). Such expenditure boosts aggregate demand, which increases tightness (Michaillat and Saez 2019, figure 2). Another part of the reason is that millions of potential labor-force participants were sent abroad on military duty (US Department of Veteran Affairs 2023). Such drastic reduction in labor force reduces labor supply, which raises tightness and reduces the unemployment rate among the workers who stayed in the United States (Michaillat and Saez 2022, figure 4).

So why didn't the Fed tighten monetary policy to reduce tightness in wartime? Indeed, a high real interest rate curbs aggregate demand, which reduces tightness and raises unemployment (Michaillat and Saez 2022, figure 5). An appropriate increase in interest rates could have brought tightness back to its full-employment level of 1 (Michaillat and Saez 2022, figure 7). In the case of World War 2, there is a simple answer. As Bernanke (2022, p. xviii) explains, during and shortly after World War 2, "at the Treasury's request, the Fed held interest rates at low levels to reduce the government's cost of financing the war."

The same happened at the beginning of the Korean War, when "facing new hostilities in Korea, President Truman pressed the Fed to keep rates low" (Bernanke 2022, p. xviii). The Fed did rebel and was allowed to phase out the low interest-rate peg that had been in place. But the phasing out came too late to cool down the labor market.

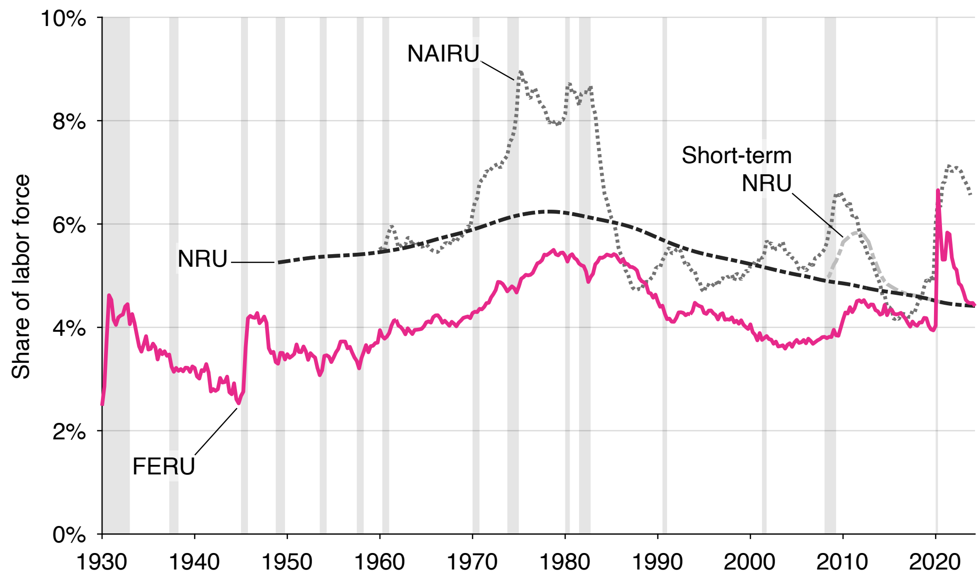
The situation during the Vietnam War was different (Bernanke 2022, pp. 20–22). The Fed raised interest rates by half a percentage point at the end of 1965, at the exact time when the economy had reached full employment. However, President Johnson was furious that the Fed tightened monetary policy. He needed low rates to help finance the war. Despite the pressure exerted by Johnson, the Fed continued increasing rates in 1966, which rapidly cooled the labor market. Worried about a possible recession, the Fed reversed its previous tightening. Under pressure from the White House, and facing a chaotic political situation, the Fed continued swinging between tightening and loosening until 1970. The lack of decisive tightening explains why the labor market remained so hot from 1966 to 1969.

V.C. Postwar period

In the postwar period, the US labor market was generally inefficiently slack (figure 4B). A manifestation of such pervasive slack is that the unemployment gap averaged 1.4pp between 1946 and 2019. Another manifestation is that the labor market did not achieve full employment once between 1970Q1 and 2018Q1: it was inefficiently slack for almost half a century.

A first possible reason to explain this slackness is that the Fed and other policymakers often use

Figure 15. FERU, NRU, and NAIRU in the United States, 1930Q1–2024Q2



Sources: The FERU comes from figure 11. The NRU is constructed by the US Congressional Budget Office (2024) for 1949Q1–2024Q2. The short-term NRU is constructed by the US Congressional Budget Office (2021) for 1949Q1–2020Q4. The NAIRU is constructed by Crump and others (2024, figure 2) for 1960Q1–2023Q4. The gray areas are NBER-dated recessions.

the NRU computed by the (US Congressional Budget Office 2024) to measure full employment. Over 1949–2019, the NRU averages 5.5% (figure 15). This is 1.2pp above the average FERU between 1949 and 2019. So policymakers might have targeted an unemployment rate that was just too high. The average distance between FERU and NRU explains by itself almost the entire average postwar unemployment gap.

Another measure of full employment that policymakers sometimes use is the NAIRU—although there is no standardized time series for it. Just like the NRU, the NAIRU appears to be significantly higher than the FERU. For instance, the NAIRU computed by Crump and others (2024, figure 2) using state-of-the-art techniques averages 5.9% over 1960–2019 (figure 15). This is 1.5pp more than the average FERU over the same period. Once again, by using the NAIRU, policymakers would have targeted an unemployment rate that was too high.

A second reason that might explain the slackness of the US labor market in the postwar period, especially after 1970, is that the Fed prioritized inflation at the expense of unemployment. Thornton (2011) reviews policy directives by the Federal Open Market Committee (FOMC) and finds that it made no reference to unemployment or full employment between 1979 and 2008—despite the dual mandate introduced in 1977. Instead, Thornton finds that the FOMC preferred "to state its objectives in terms of price stability and economic growth." This changed at the end of 2008, when the FOMC started mentioning its dual objective of "maximum employment and price stability" in policy directives and statements. Kaya and others (2019) also detect this focus on inflation in FOMC transcripts. They find that from 1960 to 2010 FOMC discussions increasingly emphasized inflation relative to unemployment, and that this shift occurred during the Volcker era and continued even as inflation declined. They conclude that "the emphasis on inflation has become entrenched and disconnected from actual inflation."

The prioritization of inflation might be due to a change in the Fed's preferences or in macroeconomic theory. It might also come from Congress. Hess and Shelton (2016) examine legislative activity to determine when Congress pressures the Fed, and whether this pressure affects monetary policy. They find that by the late 1980s Congress shifted from threatening the Fed when unemployment was high to threatening when inflation was high. This finding is consistent with Weir (1987, p. 377)'s view that "By the mid-1980s full employment had been all but erased as a major political issue in the United States." In fact, Weir (1987, p. 395) argues that although the Kennedy CEA identified an unemployment rate of 4% as full employment, in the following decades "more conservative economists [offered] ever-increasing rates of unemployment as the 'true' definition of full employment."

V.D. Great Recession

The Great Recession saw the highest unemployment gap of the 1946–2019 period, at +5.9pp, and it presented new challenges to the Fed (figure 4B). Although the unemployment gap skyrocketed in 2008–2009, the Fed was unable to respond because it ran against the zero lower bound on nominal interest rates from the end of 2008 until 2015 (Board of Governors of the Federal Reserve System 2024). The Fed could not stimulate aggregate demand through lower interest rates because it was constrained by the zero lower bound, so it could not boost tightness and lower unemployment (Michaillat and Saez 2022, figure 8). Hence, unemployment remained inefficiently high until 2018.

The Fed did resort to unconventional monetary policy, including forward guidance and quantitative easing, to reduce long-term interest rates in the aftermath of the Great Recession (Kuttner 2018). But the effectiveness of such policies is debatable (Greenlaw and others 2018; Michaillat and Saez 2021b). Moreover, the Fed may not have used these policies aggressively enough because once again they targeted an unemployment rate that was too high. The Fed commonly uses the CBO's NRU to indicate full employment. During the Great Recession the US Congressional Budget Office (2021) adjusted the NRU upward by 1pp because they believed that structural factors temporarily kept the unemployment rate high. As a result, in 2011Q4, the short-term NRU reached 5.8% (figure 15). We do find that the outward shift of the Beveridge curve after the Great Recession raised the FERU by 0.5pp, but the FERU only stood at 4.5% in 2011Q4—1.3pp below the short-term NRU.

V.E. Coronavirus pandemic

The coronavirus pandemic sharply slowed down economic activity. In 2020, the US economy reached the largest unemployment gap since the Great Depression, at +6.3pp (figure 9B). As during the Great Recession, the Fed could not respond more aggressively to the slackness of the economy because of the zero lower bound (Board of Governors of the Federal Reserve System 2024).

Thanks to aggressive expansionary fiscal policy, however, the US economy recovered rapidly from the pandemic (Romer 2021). The US economy reached full employment in 2021Q2, and continued tightening after that (figure 8B). In 2022Q2, labor-market tightness reached 1.98, a level it had not seen since the end of World War 2. It is only then, in spring 2022, that the Fed started tightening monetary policy (Board of Governors of the Federal Reserve System 2024). It is unclear why the Fed did not start tightening monetary policy earlier. After the labor market became too tight (2021Q2), an entire year passed before the Fed increased rates (2022Q2). This delay is all the more surprising since inflation was also above its target of 2% at the time. Core inflation was 3.7% in 2021Q2 and rose to 6.3% in 2022Q1 (US Bureau of Labor Statistics 2024b). Combined with the two years required by monetary policy to be fully effective (Coibion 2012), this delay explains well why the labor market remained inefficiently tight until 2024Q2.

VI. Conclusion

To conclude, we summarize our findings, review the policy prescriptions that emerge from the analysis, and explore how unemployment and vacancy data can also be leveraged to detect recessions.

VI.A. Summary

In the United States, the federal government and its central bank are mandated to stabilize the economy at full employment. However, there is no agreed-upon measure of the FERU, which makes it difficult for them to design policy to achieve full employment, and for observers to assess their performance (Duboff 1977, p. 3).

In this paper, we argue that the US FERU is given by $u^* = \sqrt{uv}$, where u is the unemployment rate and v the vacancy rate. Between 1930 and 2024, the FERU is stable, hovering around 4%. The FERU has generally been below the unemployment rate, so the US economy has generally fallen short of full employment.

VI.B. How to achieve full employment?

Since $\sqrt{uv}$ can be measured in real time, the US government and Fed could use u^* as their full-employment target. But which policies can bring the economy to full employment?

The most natural choice is monetary policy. Empirically, we know that reducing the federal funds rate lowers unemployment (Bernanke and Blinder 1992; Christiano, Eichenbaum, and Evans 1999; Coibion 2012; Ramey 2016). A midrange estimate is that lowering the nominal interest rate by 1pp decreases the unemployment rate by 0.5pp (Michaillat and Saez 2022, p. 402). Theoretically, the mechanism is simple. Reducing the federal funds rate lowers the real interest rate, which makes consumption more appealing than saving and boosts aggregate demand. A higher aggregate demand raises market tightness and lowers unemployment (Michaillat and Saez 2022, figure 5).

If the zero lower bound on nominal interest rates becomes binding, conventional monetary policy cannot restore full employment. But other policies, such as government spending, can bring the economy closer to full employment. Empirically, it is clear that government spending reduces unemployment (Monacelli, Perotti, and Trigari 2010; Ramey 2013). A midrange estimate is that raising government spending by 1% of GDP decreases the unemployment rate by 0.5pp (Michaillat and Saez 2019, p. 1325). Here again the theoretical mechanism is simple: increasing government spending boosts aggregate demand, which raises market tightness and lowers unemployment (Michaillat and Saez 2019, figure 2).

VI.C. When is it optimal to maintain the economy at full employment?

Targeting the FERU would not only satisfy the Fed's legal mandate, it would also be the optimal monetary policy in a range of models built around the Beveridge curve. For instance, in models in which inflation is fixed, the optimal monetary policy is to adjust interest rates in order to maintain unemployment at the FERU (Michaillat and Saez 2022, figure 7). In such models, monetary policy does not affect inflation, so it is optimal to keep unemployment at the FERU.

Of course fixed inflation is a strong assumption. But maintaining unemployment at the FERU is also optimal in models with endogenous inflation, as long as the divine coincidence holds (Michaillat and Saez 2024a). In such models, lower unemployment leads to higher inflation, but when the unemployment rate is efficient, inflation is on target. Therefore there is no trade-off between inflation and unemployment: maintaining unemployment at the FERU also maintains inflation on target.

How big should adjustments in interest rates be to keep the economy at full employment? Starting from a federal funds rate $r > 0$ and an inefficient unemployment rate $u \neq u^*$, the Fed should set the federal funds rate to r^* so that

$$r - r^* = \frac{u - u^*}{du/dr}, \tag{9}$$

as shown by Michaillat and Saez (2022, equation (31)). The statistic $r - r^*$ indicates the change in interest rate required to reach full employment. The statistic $u - u^*$ is the prevailing unemployment gap. And the statistic $du/dr > 0$ is the monetary multiplier: the unemployment-rate decrease achieved by lowering the nominal interest rate by 1pp. With a monetary multiplier of 0.5, formula (9) shows that the Fed should cut its interest rate by 2pp for each positive percentage point of unemployment gap, and should raise its interest rate by 2pp for each negative percentage point of unemployment gap.

If the zero lower bound becomes binding, conventional monetary policy is unable to achieve full employment (Michaillat and Saez 2022, figure 8). Government spending can bring the economy to full employment, but that might not be optimal.

VI.D. How to use the FERU in more complicated situations?

The FERU remains a useful statistic to design optimal monetary and fiscal policy even in models in which targeting the FERU is suboptimal. For instance, when government spending is not a perfect substitute for private spending, it is not optimal to use government spending to eliminate the unemployment gap (Michaillat and Saez 2019, proposition 4). Optimal government spending deviates from the Samuelson (1954) rule to reduce—but not eliminate—the unemployment gap. Yet, the FERU and unemployment gap remain key determinants of optimal government spending. The optimal level of government spending is determined by the unemployment gap, together with the elasticity of substitution between public and private consumption and the fiscal multiplier (Michaillat and Saez 2019, proposition 1).

The same logic applies to optimal monetary policy in models without divine coincidence. When the divine coincidence fails, monetary policy faces a tradeoff between closing the unemployment gap and bringing inflation to its target, so eliminating the unemployment gap is no longer optimal. Nevertheless, the optimal interest rate will depend on the unemployment gap: it will be determined by weighting the unemployment gap against the inflation gap.

To see this, consider an extension of our framework in which social welfare depends not only on unemployment but also on inflation. Let's denote the efficient inflation rate by π^*. The welfare loss around the efficient allocation (u^*, π^*) admits the following quadratic approximation:

$$\mathcal{L}(u, \pi) = (\pi - \pi^*)^2 + \alpha (u - u^*)^2, \tag{10}$$

where $\alpha > 0$ measures the importance of unemployment relative to inflation in the social welfare function.

Additionally, the central planner faces a Phillips curve that relates inflation to unemployment.

Around the efficient allocation, the Phillips curve admits the following linear approximation:

$$\pi - \pi^* = -\beta\left(u - u^*\right) + \gamma, \tag{11}$$

where $\beta > 0$ gives the slope of the downward-sloping Phillips curve, and $\gamma \neq 0$ is introduced to break the divine coincidence. Indeed, if $\gamma = 0$, then $\pi = \pi^*$ when $u = u^*$: inflation is on target at full employment, so the divine coincidence holds. If $\gamma > 0$, then $\pi > \pi^*$ when $u = u^*$: inflation is too high at full employment, so unemployment must be above the FERU to bring inflation to target, just like in the 1970s. Conversely, if $\gamma < 0$, then $\pi < \pi^*$ when $u = u^*$: inflation is too low at full employment.

The Beveridgean Phillips curve developed by Michaillat and Saez (2024a) links the unemployment and inflation gaps, but it also guarantees that the divine coincidence holds, so $\gamma = 0$ in the approximation (11). More work is required to understand why the divine coincidence might fail and to identify the economic forces driving $\gamma \neq 0$.

The social planner minimizes the welfare loss (10) subject to the Phillips curve (11). Inflation can be substituted out of the welfare loss using the Phillips curve. Then, the planner's problem is to find $u \in [0, 1]$ to minimize

$$\left[-\beta\left(u - u^*\right) + \gamma\right]^2 + \alpha\left[u - u^*\right]^2.$$

This objective function is strictly convex in u, so the first-order condition is sufficient to find its minimum. We take the function's derivative with respect to u and set it to 0:

$$0 = -2\beta\left[-\beta\left(u - u^*\right) + \gamma\right] + 2\alpha\left[u - u^*\right].$$

Rearranging terms, we express the optimal unemployment gap as a function of the parameters:

$$u - u^* = \frac{\beta\gamma}{\alpha + \beta^2}. \tag{12}$$

Plugging (12) in the Phillips curve (11), we also express the optimal inflation gap as a function of the same parameters:

$$\pi - \pi^* = \frac{\alpha\gamma}{\alpha + \beta^2}. \tag{13}$$

From these two expressions, we also obtain a simple expression for the ratio between the optimal unemployment and inflation gaps:

$$\frac{u - u^*}{\pi - \pi^*} = \frac{\beta}{\alpha}. \tag{14}$$

The tradeoff between inflation and unemployment in the absence of divine coincidence clearly appears in these equations. Consider the case where inflation is too high at the FERU ($\gamma > 0$). Then (12) and (13) say that it is optimal to keep unemployment above the FERU ($u > u^*$) and inflation above its target ($\pi > \pi^*$). Furthermore, (14) shows that the optimal gaps are determined by the welfare cost of unemployment relative to inflation (α) and the response of inflation to unemployment (β). If unemployment is particularly costly (high α) or if the Phillips curve is flat (low β), the optimal unemployment gap is small relative to the optimal inflation gap. In such cases, the optimal unemployment rate remains close to the FERU, either due to the high marginal cost of unemployment (high α) or the limited marginal benefit of unemployment (low β).

The equations provide two additional insights. First, if the divine coincidence holds ($\gamma = 0$), then it is optimal to keep unemployment at the FERU ($u = u^*$ in (12)), which guarantees that inflation hits its target ($\pi = \pi^*$ in (13)). Second, it is never optimal for the unemployment and inflation gaps to have opposite signs ($(u - u^*)/(\pi - \pi^*) > 0$ in (14)). This is because welfare can be improved if the gaps take opposite signs. For example if the unemployment gap is negative and the inflation gap is positive (as in 2021–2024), then raising unemployment reduces the unemployment gap and, by cooling inflation, reduces the inflation gap—thereby improving welfare.

VI.E. Using unemployment and vacancy data to detect recessions

Finally, the combination of vacancy and unemployment data has other interesting business-cycle applications. Vacancy data are the black sheep of business-cycle data: they are not well known, not well understood, and not widely trusted. Yet, when combined with unemployment data, they are extremely powerful to understand business cycles. This paper provides an example of the normative power of the vacancy-unemployment combination. Michaillat and Saez (2024b) show that the vacancy-unemployment combination has predictive power too.

Michaillat and Saez (2024b) develops a new Sahm (2019)-type recession rule that combines vacancy and unemployment data. The new rule has greater foresight than the Sahm rule—which only uses unemployment data. It detects recession starts with a lag of 0.8 month on average, while the Sahm rule detects them with a lag of 2.1 months. The new rule also has a better historical track record. It perfectly identifies the 15 recessions that have occurred since 1929, without any false positives, while the Sahm rule breaks down before 1960.

In the present context, Michaillat and Saez (2024b)'s recession rule says that the US economy may have entered a recession as early as March 2024. As of August 2024, the probability that the US economy is in recession is 48%.

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