Beveridgean Unemployment Gap

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This paper measures the unemployment gap (the difference between actual and efficient unemployment rates) using the Beveridge curve (the negative relationship between unemployment and job vacancies). We express the unemployment gap as a function of current unemployment and vacancy rates, and three sufficient statistics: elasticity of the Beveridge curve, recruiting cost, and nonpecuniary value of unemployment. In the United States, we find that the efficient unemployment rate started around 3% in the 1950s, steadily climbed to almost 6% in the 1980s, fell just below 4% in the early 1990s, and remained at that level until 2019. These variations are caused by changes in the level and elasticity of the Beveridge curve. Hence, the US unemployment gap is almost always positive and highly countercyclical—indicating that the labor market tends to be inefficiently slack, especially in slumps.

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1. Introduction

The unemployment gap—the distance between actual and efficient unemployment rates—is a key statistic for macroeconomic policy. In practice, many governments are mandated to reduce the unemployment gap to zero. For example, in the United States, the Humphrey-Hawkins Full Employment Act of 1978 mandates the government to maintain the economy at "full employment." Since achieving zero unemployment is physically impossible, full employment should not be interpreted as zero unemployment but rather as an efficient amount of unemployment; the mandate of US policymakers therefore is to close the unemployment gap. In theory, many optimal policies also depend on the distance from labor-market efficiency, measured by the unemployment gap: hiring and employment subsidies and firing tax (Pissarides 2000, chap. 9); minimum wage (Hungerbuhler and Lehmann 2009); monetary policy (Michaillat and Saez 2014); public expenditure (Michaillat and Saez 2019); income tax (Kroft et al. 2019); and short-time work (Giupponi and Landais 2018). Yet, perhaps surprisingly, there does not exist any broadly accepted measure of the unemployment gap.

This paper develops a measure of the unemployment gap based on the Beveridge curve. The curve depicts a negative relationship between unemployment and job vacancies. It was first identified by Beveridge (1944) and Dow and Dicks-Mireaux (1958) in the United Kingdom, and has since been observed in many countries (Jackman, Pissarides, and Savouri 1990; Nickell et al. 2002; Elsby, Michaels, and Ratner 2015), including the United States (Blanchard and Diamond 1989; Diamond and Sahin 2015; Elsby, Michaels, and Ratner 2015). The Beveridge curve is key to determining the efficient unemployment rate because it governs the welfare tradeoff between unemployment and vacancies. Both unemployment and vacancies come with welfare costs: more unemployment means fewer productive resources; more vacancies means more productive resources diverted to recruiting. Yet the Beveridge curve shows that both cannot be reduced at the same time: less unemployment requires more vacancies, and conversely fewer vacancies create more unemployment. Our analysis determines the efficient unemployment rate: the rate at which welfare is maximized.

We begin by expressing the unemployment gap as a function of actual unemployment and vacancy rates, and three sufficient statistics: elasticity of the Beveridge curve, recruiting cost, and nonpecuniary value of unemployment. These statistics enter the formula because they determine the marginal welfare cost and benefit from changing unemployment, and ultimately the efficient rate of unemployment. Consider for instance a small decrease in unemployment. On the plus side, market production mechanically increases. On the minus side, newly employed workers forgo the nonpecuniary value of unemployment, such as home production. Also on the minus side, more vacancies are required to sustain lower unemployment, as described by the Beveridge curve, which forces firms to allocate more workers to recruiting, thus reducing production. We obtain our formula from the condition that when unemployment is efficient, the pluses and minuses balance out.

Next, we apply our unemployment-gap formula to the United States. We find that the efficient unemployment rate started around 3% in the 1950s, steadily climbed to almost 6% in the 1980s, fell just below 4% in the early 1990s, and remained at that level until 2019. These variations are caused by changes in the level and elasticity of the Beveridge curve. Hence, the US unemployment gap is almost always positive—indicating that the labor market does not generally operate efficiently, but tends to be inefficiently slack. The unemployment gap is especially high in slumps: as high as 5 percentage points in 1982, 3.9 points in 1992, and 6.2 points in 2010. Thus, it would be beneficial to implement stabilization policies that reduce unemployment in bad times.

Of the three statistics in our formula, the most uncertain is the nonpecuniary value of unemployment. Our mid-range estimate of the nonpecuniary value of unemployment relative to employment is 0.24 (see Borgschulte and Martorell 2018), suggesting that unemployed workers derive a small value from unemployment—from added leisure or home production. Yet, survey evidence suggests that the nonpecuniary value of unemployment could be quite negative, possibly due to lower mental health. Using such survey calibration, the efficient unemployment rate is a bit lower, around 3%. At the other end of the range of available estimates, some macro studies argue that the nonpecuniary value of unemployment could be almost as high as labor productivity (see Hagedorn and Manovskii 2008). Under such calibration the efficient unemployment rate is much higher, above 13%, so that unemployment is always inefficiently low, even at the peak of the Great Recession. This result seems implausible, suggesting that such macro calibration overstates the nonpecuniary value of unemployment.

Conceptually, our measure of the unemployment gap is quite different from the two common measures in the literature (see Crump et al. 2019). The first common measure is the gap between actual unemployment and its secular trend. This measure and ours differ because trend unemployment is separate from efficient unemployment. Indeed, unemployment is generally not efficient on average (Pissarides 2000, chap. 8). The second common measure is the gap between actual unemployment and the non-accelerating inflation rate of unemployment (NAIRU, obtained by estimating a Phillips curve). This measure and ours differ because the NAIRU is not a measure of labor-market efficiency (Rogerson 1997).

Methodologically, our approach to measuring the unemployment gap differs from the typical macroeconomic approach. The macro approach consists in computing the unemployment gap by simulating a calibrated model of the economy subject to real-time shocks (for example, Gertler, Sala, and Trigari 2008; Gali, Smets, and Wouters 2012). It requires an accurate structural model of the economy, and real-time observations of all the shocks disturbing the economy. It thus faces two difficulties: all available models are somewhat controversial, and shocks are incredibly difficult to estimate (Hall 2005c). To tackle these difficulties, we import the sufficient-statistic method from public economics (Chetty 2009). Our formula requires little theoretical structure and therefore applies to a broad range of models: it applies to any model admitting a Beveridge curve, and does not require any assumptions about labor-market structure, wage setting, labor demand, or underlying shocks. Second, our formula only involves potentially estimable statistics, so it can be used to measure the unemployment gap in real time.

Finally, our formula can be seen as a reformulation of the well-known Hosios condition. Like us, Hosios (1990) resolves the tradeoff between unemployment and vacancies to maximize welfare. He then derives a condition to ensure that when wages are determined by Nash bargaining, labor market efficiency is achieved. The condition is that workers' bargaining power equals the elasticity of the matching function with respect to unemployment. But measuring workers' bargaining power is notoriously challenging (Pissarides 2000, p. 229).[1] Moreover, Nash bargaining does not seem to describe well wage-setting at business-cycle frequency (Shimer 2005; Hall 2005a; Jager et al. 2018). For these reasons we do not attempt to use the Hosios condition to measure the unemployment gap. Instead, we derive a formula that links the efficient unemployment rate to observable labor market statistics. Our formula also slightly generalizes the Hosios condition in that it applies not only to models with a matching function and Nash bargaining, but also to other models with a Beveridge curve, irrespective of their wage-setting mechanism.

2. Beveridgean labor market

We introduce the labor market model used to compute the unemployment-gap formula. The main ingredient is a Beveridge curve: a decreasing function giving the vacancy rate prevailing on the labor market for any unemployment rate. Because of the Beveridge curve, there always are unemployed workers and vacant jobs. Moreover, the number of unemployed workers and vacant jobs is generally inefficient.

[1]The challenge is such that the bargaining power is usually simply calibrated to 0.5 (for example, den Haan, Ramey, and Watson 2000; Pissarides 2000; Gertler and Trigari 2009) or to the value implied by the Hosios condition (for example, Mortensen and Pissarides 1994; Shimer 2005; Costain and Reiter 2008).

2.1. Beveridge curve

We consider a labor market with both unemployed workers and vacant jobs. The unemployment rate u is the number of unemployed workers divided by size of the labor force. The vacancy rate v is the number of vacancies divided by size of the labor force. The labor market tightness is the ratio of vacancy rate to unemployment rate: $\theta = v/u$.

Unemployment rate and vacancy rate are related by a Beveridge curve. Formally, the vacancy rate is given by the function $v(u)$, which is strictly decreasing and convex. A key statistic in the measure of the unemployment gap is the Beveridge elasticity:

Definition 1. *The Beveridge elasticity is the elasticity of the vacancy rate with respect to the unemployment rate along the Beveridge curve, normalized to be positive:*

$$\epsilon = -\frac{u}{v(u)}v'(u) = -\frac{d\ln(v(u))}{d\ln(u)}.$$

The Beveridge curve is clearly visible on the US labor market since the 1950s. To display it, we need measures of the unemployment and vacancy rates. For the unemployment rate, we use the measure constructed by the Bureau of Labor Statistics (BLS) from the Current Population Survey (CPS) (figure 1, panel A). For the vacancy rate, we use two different sources because there is no continuous national vacancy series in the United States over the period. For the 1951Q1–2000Q4 period, we use the vacancy proxy constructed by Barnichon (2010). Barnichon starts from the help-wanted advertising index constructed by the Conference Board—a proxy for vacancies proposed by Abraham (1987), which has become standard (Shimer 2005, p. 29). He then corrects the Conference Board index, which is based on newspaper advertisements, to take into account the shift from print advertising to online advertising after 1995.[2] Finally, he rescales the index into vacancies, and divides the vacancy number by the size of the labor force to obtain a vacancy rate.[3] For the 2001Q1–2019Q2 period, we obtain the vacancy rate from the number of job openings measured by the BLS in the Job Opening and Labor Turnover Survey (JOLTS), divided by the civilian labor force constructed by the BLS from the CPS. We then splice the Barnichon and JOLTS series to obtain a vacancy rate for 1951Q1–2019Q2 (figure 1, panel B).

The Beveridge curve appears in scatter plots of unemployment and vacancy rates (panels C and D of figure 1; for readability, we separately plot the 1951Q1–1987Q3 and 1987Q4–2019Q2 periods).

[2] Abraham (1987) was concerned that the Conference Board index might have been a biased proxy for vacancies in the 1970s and 1980s, because at that time, the structure of the newspaper industry significantly changed, and business changed how they used help-wanted advertising in response to antidiscrimination laws. However, Zagorsky (1998, p. 343) finds that such bias is minimal, and that the Conference Board index tracks vacancies well until 1994.

[3] The conversion of the index into a vacancy rate is not in Barnichon's article but is implemented in the 2016 version of the vacancy proxy, available at https://sites.google.com/site/regisbarnichon/research.

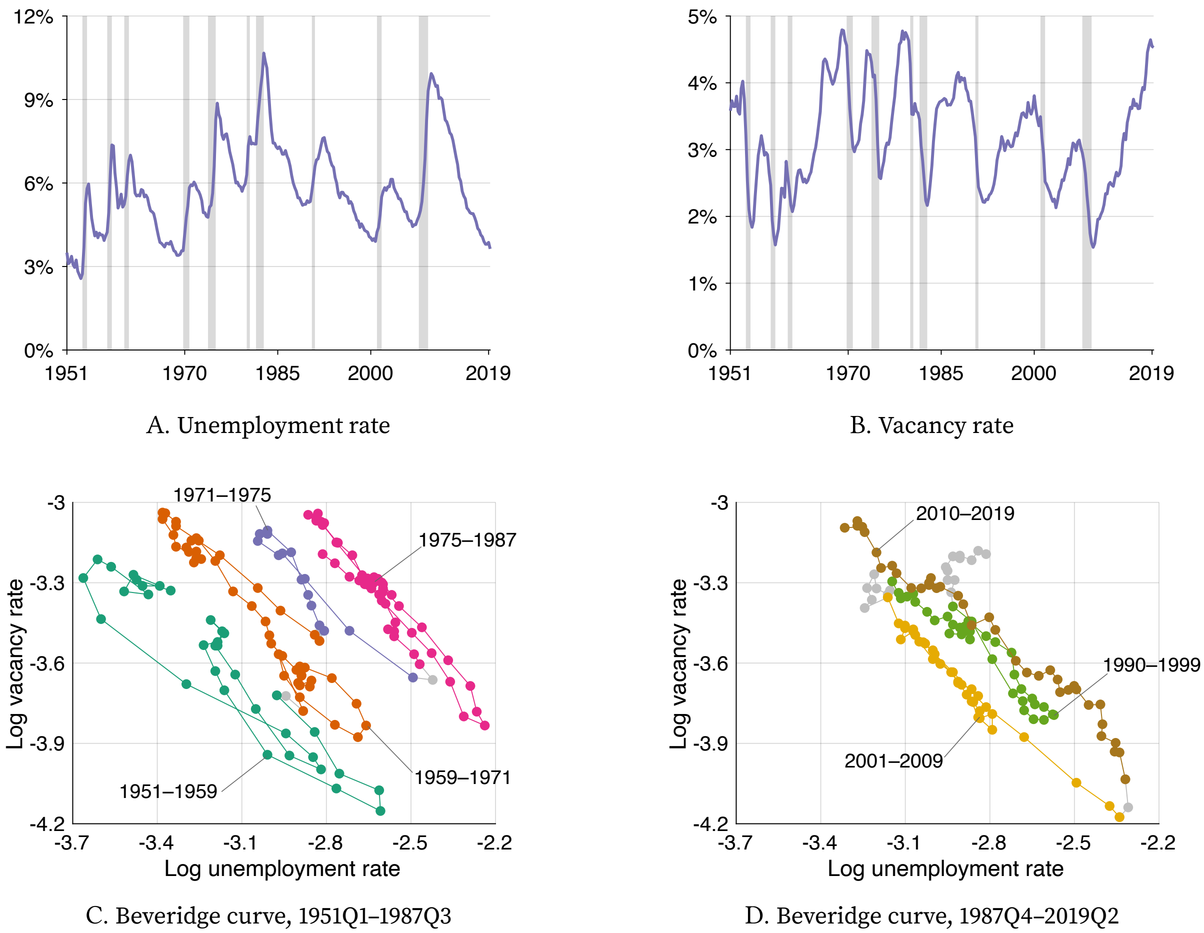

FIGURE 1. Beveridge curve in the United States, 1951Q1–2019Q2

Panel A: The unemployment rate is constructed by the BLS from the CPS. Panel B: For 1951Q1–2000Q4, the vacancy rate is constructed by Barnichon (2010) from the Conference Board help-wanted advertising index; for 2001Q1–2019Q2, the vacancy rate is the number of job openings measured by the BLS in JOLTS, divided by the civilian labor force constructed by the BLS from the CPS. All unemployment and vacancy rates are quarterly averages of seasonally adjusted monthly series. The shaded areas represent recessions, as identified by the National Bureau of Economic Research (NBER). Panels C & D: The Beveridge curve is a scatter plot of log unemployment rate (from panel A) vs. log vacancy rate (from panel B). Panel C depicts the 1951Q1–1987Q3 period, and panel D the 1987Q3–2019Q2 period. The panels highlight in color the subperiods during which the Beveridge curve was stable: 1951Q1–1959Q2, 1959Q4–1971Q1, 1971Q3–1975Q1, 1975Q3–1987Q3, 1990Q2–1999Q1, 2001Q1–2009Q3, and 2010Q1–2019Q2. In-between quarters, during which the Beveridge curve shifts, are depicted in gray.

The Beveridge curve is stable over long periods of time, and shifts outward or inward every so often. The Beveridge curve was stable for seven subperiods, during which unemployment and vacancies moved up and down along a clearly defined curve: 1951Q1–1959Q2, 1959Q4–1971Q1, 1971Q3–1975Q1, 1975Q3–1987Q3, 1990Q2–1999Q1, 2001Q1–2009Q3, and 2010Q1–2019Q2. At the end of the first three subperiods, the Beveridge curve shifted outward. After the 1975Q3–1987Q3 and 1990Q2–1999Q1 subperiods, the Beveridge curve shifted back inward. Finally, after the 2001Q1–2009Q3 subperiod, at the end of the Great Recession, the Beveridge curve shifted back outward.

Another property of the empirical Beveridge curve is that all its branches (plotted in log) seem almost perfectly linear, suggesting that each branch is isoelastic.

Seeing a Beveridge curve on the US labor market is not surprising: its presence has long been established (Blanchard and Diamond 1989; Diamond and Sahin 2015; Elsby, Michaels, and Ratner 2015). The Beveridge curve has also been observed in numerous other countries (Jackman, Pissarides, and Savouri 1990; Nickell et al. 2002; Elsby, Michaels, and Ratner 2015).

Many labor market models feature a Beveridge curve and are therefore covered by our framework (Elsby, Michaels, and Ratner 2015). Importantly, models build around standard matching functions exhibit a Beveridge curve (Petrongolo and Pissarides 2001, eq. (12)).[4] This category includes the canonical Diamond-Mortensen-Pissarides model (Pissarides 2000, chap. 1; Shimer 2005); but also its variants with rigid wages (Hall 2005a; Hall and Milgrom 2008), with large firms (Cahuc, Marque, and Wasmer 2008; Elsby and Michaels 2013), or with job rationing (Michaillat 2012). Even models without a matching function may feature a Beveridge curve: for instance, models of mismatch (Shimer 2007) and of stock-flow matching (Ebrahimy and Shimer 2010).

2.2. Social welfare

The Beveridge curve determines the tradeoff between unemployment and vacancies. Both have welfare costs, which we describe here.

Vacancies. The welfare cost of vacancies arises because filling a vacancy requires labor: $\rho > 0$ workers per unit time. Hence, vacancies divert labor away from production and toward recruiting—

[4] In many models with a matching function, the unemployment rate follows a law of motion, and the Beveridge curve is defined as the locus of unemployment and vacancy rates that are consistent with a stable level of unemployment in the absence of shocks. Technically, therefore, unemployment and vacancy rates may not be on the Beveridge curve if unemployment moves very slowly over time. However, as noted by Pissarides (2009a, p. 236), "Perhaps surprisingly at first, but on reflection not so surprisingly, we get a good approximation to the dynamics of unemployment if we treat unemployment as if it were always on the Beveridge curve." The reason is that labor market flows are so large that after a shock, the unemployment rate adjusts very rapidly to its new stable level, where inflows into unemployment equal outflows from unemployment (Pissarides 1986; Hall 2005b; Pissarides 2009b; Elsby, Michaels, and Solon 2009; Shimer 2012).

an activity that does not directly contribute to welfare.

The share of the labor force devoted to filling vacancies at any point in time is ρv. Recruiters spend time and effort finding appropriate workers for their firm. As a result, the recruiters do not have time to produce the goods and services sold by firms to consumers. In contrast, a fraction n of the labor force is devoted to the production of goods or services eventually consumed by firms' customers. Since all workers are either producers or recruiters, and since the employment rate is $1 - u$, the share of producers in the labor force is

$$n = 1 - u - \rho v.$$

The number of producers is below the size of the labor force because some workers do not find jobs ($u > 0$), and some workers are allocated to recruiting instead of producing ($\rho v > 0$).

Unemployment. Welfare is determined by the number of producers and unemployed workers. Unemployed workers contribute positively to welfare if they enjoy additional utility from leisure or through home production; they contribute negatively if they suffer mental and physical health cost or loss of human capital. Since the size of the labor force is taken as given, we assume that welfare is given by a function $\mathcal{W}(n, u)$, where u is the unemployment rate, n is the share of the labor force that is employed and devoted to production of consumption goods and services, and the function $\mathcal{W}$ is strictly increasing in both arguments.

The welfare cost of unemployment arises because unemployed workers contribute less to social welfare than production workers (if not, it would be optimal to have everybody unemployed). A key statistic in the measure of the unemployment gap is the nonpecuniary value of unemployment relative to production:

Definition 2. *The nonpecuniary value of unemployment is the marginal rate of transformation between unemployed workers and production workers in the welfare function:*

$$z = \frac{\partial \mathcal{W} / \partial u}{\partial \mathcal{W} / \partial n} < 1.$$

The statistic z captures the value of leisure and of home production, net of the psychological costs of being unemployed, relative to the value of market production. It measures the resource value/cost of unemployment and hence should not include unemployment benefits, which are transfers from employed to unemployed workers. Accordingly, as in Hosios (1990), our analysis abstracts from the issue of insurance—which is covered by Landais, Michaillat, and Saez (2018a,b).

The textbook Diamond-Mortensen-Pissarides model, with linear production and utility functions, provides a simple example of welfare function. Assume that the size of the labor force is 1; the productivity of employed workers is a; and the productivity of unemployed workers in home production is $a \times h$, where the presence of the factor a reflects the fact that technological advances benefit both firm and home production (appliances, computers, infrastructure, and so on), and $h < 1$ is labor productivity at home relative to on the job. Assume also that the value of time is the same at home and on the job. The welfare function then is

$$\mathcal{W}(n, u) = an + ahu = (n + hu)a.$$

Here the nonpecuniary value of unemployment simply is $z = h$.

3. Unemployment-gap formula

We first provide a graphical representation of the efficient unemployment rate and unemployment gap in a Beveridge plan. Then we develop a sufficient-statistic formula for the unemployment gap. The formulas apply to any labor market model in which unemployment and vacancy rates are related by a Beveridge curve.

Definition 3. *Social welfare is given by the following function of the unemployment rate u:*

$$\mathcal{W}(1 - u - \rho v(u), u), \tag{1}$$

where $\mathcal{W}(n, u)$ is the welfare function, ρ is the recruiting cost, and $v(u)$ is the Beveridge curve. The efficient unemployment rate, denoted u^*, maximizes social welfare. The efficient vacancy rate is $v^* = v(u^*)$, the efficient labor market tightness is $\theta^* = u^*/v^*$, and the unemployment gap is $u - u^*$.

As in Hosios (1990), we determine the unemployment rate that maximizes welfare at any point in time. We do not incorporate any dynamical elements to the analysis. This simplification allows us to obtain a simple graphical representation and a sufficient-statistic formula.

3.1. Representation in Beveridge plan

Since the efficient unemployment rate maximizes (1), it satisfies the first-order condition

$$[1 + \rho v'(u)] \frac{\partial \mathcal{W}}{\partial n} = \frac{\partial \mathcal{W}}{\partial u}.$$

After dividing by $\partial\mathcal{W}/\partial n$ and reshuffling the terms, we obtain

$$v'(u) = -\frac{1-z}{\rho}. \tag{2}$$

We assume that the maximization problem is well behaved: the function $u \mapsto \mathcal{W}(1-u-\rho v(u), u)$ admits a unique extremum, and the extremum is an interior maximum. Under this assumption, (2) is a necessary and sufficient condition for optimality. This gives us a first result:

Proposition 1. *In a Beveridge plan, the efficient unemployment rate is found at the point where the Beveridge curve is tangent to a downward-sloping line with slope $-(1-z)/\rho$, where $z < 1$ is the nonpecuniary value of unemployment and $\rho > 0$ is the recruiting cost.*

This result is depicted on figure 2, panel A. The graph shows a standard Beveridge plan, with unemployment rate on the x-axis and vacancy rate on the y-axis. The Beveridge curve is a downward-sloping and convex curve in the plan. The efficient unemployment rate, and corresponding efficient vacancy rate, are found at the point of tangency between the Beveridge curve and a downward-sloping line with slope $-(1-z)/\rho$.

Formula (2) transparently describes the determinants of the efficient unemployment rate. When the labor market operates efficiently we have (2), so

$$1 - z = -\rho v'(u). \tag{3}$$

The condition says that at efficiency, welfare costs and benefits from moving one worker from unemployment to employment are equalized. When one worker moves from unemployment to employment, more welfare is produced since $z < 1$. Hence, the welfare contribution of an extra job is $1-z$. At the same time, there is a tradeoff between unemployment and vacancies: having one less unemployed worker means having $-v'(u) > 0$ more vacancies, which diverts an extra $\rho[-v'(u)]$ workers away from production and toward recruiting. Hence, the welfare cost of an extra job is $\rho[-v'(u)]$.

The representation of the efficient unemployment rate in the Beveridge plan offers several comparative-static results, illustrated in panels B, C, and D of figure 2:

Corollary 1. *The efficient unemployment rate increases in the following cases*

- *when the recruiting cost increases;*
- *when the nonpecuniary value of unemployment increases;*
- *when the Beveridge elasticity increases;*

- *and when mismatch increases (such that the Beveridge curve becomes $\mu \times v(u)$ where $\mu > 1$ is the mismatch factor).*

The intuitions are simple. When unemployment is more valuable (higher nonpecuniary value) or vacancies are more costly (higher recruiting cost), then the efficient unemployment rate increases. When reducing unemployment requires more vacancies (higher Beveridge elasticity), then vacancy-unemployment tradeoff becomes less favorable to unemployment, and the efficient unemployment rate increases. The same mechanism operates with an increase in mismatch. At any unemployment rate, the Beveridge curve becomes steeper (the derivative becomes $\mu v'(u) > v'(u)$), so reducing unemployment requires more vacancies, which implies a higher efficient unemployment rate.

Over the business cycle, the unemployment and vacancy rates move along the Beveridge curve (figure 1, panels C and D). When ρ and z remain stable, such movements lead to fluctuations in the unemployment gap. In slumps (figure 2, panel E), the unemployment rate is too high, the vacancy rate is too low, and the unemployment gap is positive. In booms (figure 2, panel F), the unemployment rate is too low, the vacancy rate is too high, and the unemployment gap is negative.

3.2. Expression in terms of sufficient statistics

We rework the optimality condition (2) to obtain a formula that we can use to measure the unemployment gap in real time. The issue with (2) is that the slope of the Beveridge curve $v'(u)$ changes over time, so it would be difficult to estimate in real time. In contrast, the Beveridge elasticity $\epsilon = -(u/v)v'(u) = -v'(u)/\theta$ is stable over time, as showed by the linearity of the branches of the Beveridge curve (figure 1, panels C and D). We therefore re-express (2) with the Beveridge elasticity:

$$-\frac{v'(u)}{\theta} \cdot \theta = \frac{1-z}{\rho},$$

which gives at the optimum $\epsilon\theta = (1-z)/\rho$. Hence the efficient labor market tightness only depends on three sufficient statistics:

Proposition 2. *The efficient labor market tightness only depends on the Beveridge elasticity (ϵ), recruiting cost (ρ), and nonpecuniary value of unemployment (z):*

$$\theta^* = \frac{1-z}{\rho\epsilon}. \tag{4}$$

Condition (4) gives the labor market tightness that maximizes welfare on a Beveridgean labor market, where unemployed workers and vacant jobs coexist. The condition involves the

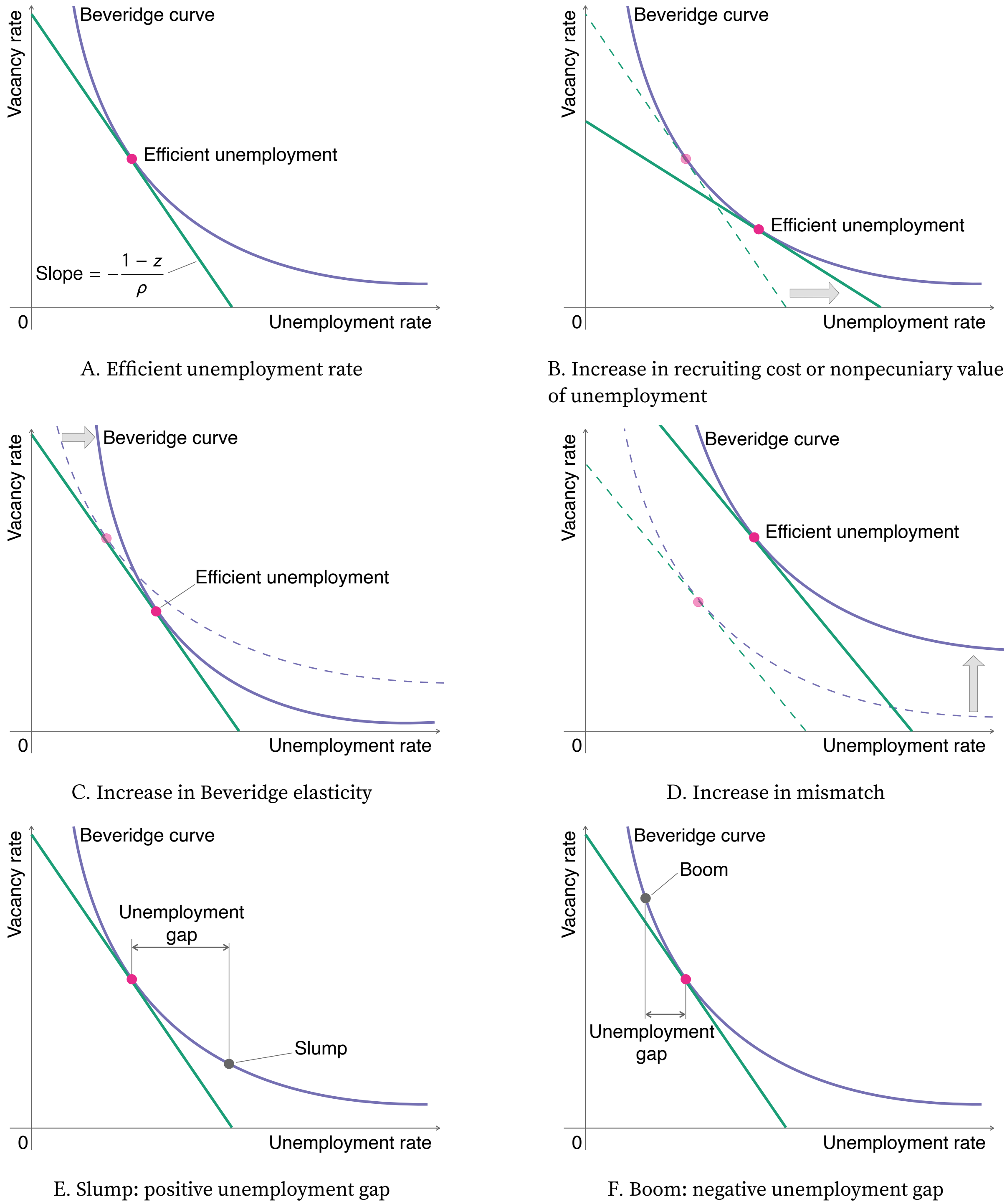

FIGURE 2. Efficient unemployment rate and unemployment gap in Beveridge plan

Panel A depicts the derivation of the efficient unemployment rate in the Beveridge diagram. The parameter z is the nonpecuniary value of unemployment (relative to production), and the parameter ρ is the recruiting cost (labor cost of posting a vacancy). Panel B shows that the efficient unemployment rate increases when the recruiting cost or the nonpecuniary value of unemployment increases. Panel C shows that the efficient unemployment rate increases when mismatch increases. Panel D shows that the efficient unemployment rate increases when the Beveridge elasticity increases. Panels E & F describe inefficient labor markets: unemployment and vacancies satisfy the Beveridge curve but not the efficiency condition. Panel E depicts a slump: unemployment is inefficiently high, vacancies are inefficiently low, and there is a positive unemployment gap. Panel F depicts a boom: unemployment is inefficiently low, vacancies are inefficiently high, and there is a negative unemployment gap.

Beveridge elasticity ϵ because it controls the tradeoff between unemployment and vacancies. It also features the two parameters measuring the welfare cost of unemployment and vacancies: the nonpecuniary value of unemployment $z < 1$ and the recruiting cost $\rho > 0$.

We expect the efficient tightness to be fairly stable over time because it is unaffected by two prevalent labor market shocks. First, it is unaffected by labor-demand shocks, such as productivity shocks, wage shocks, or aggregate demand shocks. These shocks move the labor market along the Beveridge curve without affecting z or ρ. Second, it is unaffected by mismatch shocks, which shift the Beveridge curve inward or outward without affecting ϵ.

The efficient labor market tightness is easy to visualize on the diagrams in figure 2: it is the slope of the origin line going through the efficient point on the Beveridge curve.

With (4) in hand, we can obtain a formula for the unemployment gap. Guided by the evidence from panels C and D in figure 1, we assume that the Beveridge curve is isoelastic:

$$v(u) = v_0 \cdot u^{-\epsilon},$$

with Beveridge elasticity $\epsilon > 0$. This isoelastic expression implies that along the Beveridge curve, tightness is related to unemployment rate by $\theta = v(u)/u = v_0 u^{-(1+\epsilon)}$ and $\theta^* = v_0 (u^*)^{-(1+\epsilon)}$. The link between efficient tightness and efficient unemployment rate implies that $u^* = (\theta^*/v_o)^{-1/(1+\epsilon)}$. Hence, in addition to the factors affecting the efficient tightness, the efficient unemployment rate is also affected by shifts in the Beveridge curve (changes in v_0). This implies that in theory, the efficient labor market tightness is more stable than the efficient unemployment rate.

From the previous relationships, we link the unemployment gap to the tightness gap:

$$\frac{u^*}{u} = \left(\frac{\theta}{\theta^*}\right)^{1/(1+\epsilon)}.$$

Hence the unemployment gap only depends on current unemployment and vacancy rates, and the same three sufficient statistics:

PROPOSITION 3. *The efficient unemployment rate and unemployment gap can be measured from current unemployment rate (u), current vacancy rate (v), Beveridge elasticity (ϵ), recruiting cost (ρ), and nonpecuniary value of unemployment (z). The efficient unemployment rate is given by*

$$u^* = \left(\frac{\rho\epsilon}{1-z} \cdot \frac{v}{u}\right)^{1/(1+\epsilon)} u, \tag{5}$$

from which the unemployment gap $u - u^*$ immediately follows.

The proposition gives an explicit formula for the unemployment gap, expressed in terms of observable sufficient statistics. It is valid in any Beveridgean labor market model, irrespective of firms' production function, workers' utility function, the wage mechanism, or the structure of the labor market. Another advantage of our formula is that we do not need to take a stand on or measure the shocks disturbing the labor market: productivity, wage, labor-force participation, matching function, job separations, and so on. The sufficient statistics are all we need to observe.

4. Unemployment gap in the United States, 1951–2019

We apply formula (5) to measure the unemployment gap in the United States over the 1951–2019 period. The first step is to measure the following statistics: Beveridge elasticity (ϵ), recruiting cost (ρ), and nonpecuniary value of unemployment (z). We also compare our unemployment-gap measure to other existing measures, and we describe its sensitivity to the nonpecuniary value of unemployment.

4.1. Beveridge elasticity

We estimate the Beveridge elasticity ϵ by OLS regression of log vacancy rate on log unemployment rate. Since the Beveridge curve shifts over time, we separately estimate the elasticity on the seven subperiods during which the Beveridge curve was stable: 1951Q1–1959Q2, 1959Q4–1971Q1, 1971Q3–1975Q1, 1975Q3–1987Q3, 1990Q2–1999Q1, 2001Q1–2009Q3, and 2010Q1–2019Q2 (figure 1). One such regression is illustrated in figure 3, panel A; the regression results on each subsample are summarized in figure 3, panel B.[5]

We find that during the 1951–2019 period, the Beveridge elasticity fluctuates between 0.84 and 1.24. The Beveridge elasticity steadily increased from 0.92 in the 1950s to 1.24 in the 1980s, before suddenly dropping back below 1 in 1990, and dropping further to 0.84 in 2010. Furthermore the fit of the seven linear regressions is very good: the R^2 varies between 0.90 and 0.97. Such high R^2 confirms that unemployment and vacancy travel on tightly defined branches of the Beveridge curve, and that each branch is almost perfectly isoelastic.

4.2. Recruiting cost

To construct the recruiting cost ρ, we rely on the evidence from the 1997 National Employer Survey: in this survey, the Census Bureau asked 4,500 establishments about their recruiting process, and found that firms spend 2.5% of their labor costs on recruiting (Villena Roldan 2010). This means that in 1997, $\rho v = 2.5\% \times (1 - u)$. Moreover, the average vacancy rate in 1997 is 3.3% (figure 1,

[5] The Beveridge elasticity is precisely estimated: across the seven regressions the standard error varies between 0.02 and 0.10.

panel B). At the same time, the average unemployment rate is 4.9% (figure 1, panel A). Hence, using these 1997 data, we find that the recruiting cost is $\rho = 2.5\% \times (1 - 4.9\%)/3.3\% = 0.72$.

As there is no other comprehensive measure of recruiting cost at other dates in the United States, we assume that the recruiting cost remains constant at its 1997 value.

4.3. Nonpecuniary value of unemployment

The nonpecuniary value of unemployment z measures the well-being of an unemployed worker, without receiving any monetary transfers from the government or others, relative to the productivity of an employed worker. To measure it, we rely on the work of Borgschulte and Martorell (2018). Using military administrative data for the 1993–2004 period, they study how servicemembers' choice between reenlisting and exiting the military is affected by the unemployment rate in the local labor market where they would enter. They are able to measure the dollar value of utility lost in the transition to civilian employment when unemployment is one percentage point higher, and compare this value to actual earnings losses for military leavers subject to different labor markets. Their main finding is that between 13% and 35% of the estimated earnings loss (the value of employment) is offset by leisure and home production (the nonpecuniary value of unemployment) as well as by public benefits (the pecuniary value of unemployment)—giving a midpoint of 24%.

Since servicemembers' benefits are not observed in the dataset, we abstract from benefits and set the nonpecuniary value of unemployment to $z = 0.24$. (Accounting for benefits would reduce z further.) And since we have no evidence on the time variations of the nonpecuniary value of unemployment, we assume it to be constant.

4.4. Unemployment gap

Using formula (5), the calibrated statistics, and the unemployment and vacancy rates from figure 1, we now measure the unemployment gap in the United States between 1951 and 2019.

We begin by computing the efficient labor market tightness using formula (4) (figure 3, panel C). Mirroring the movements of the Beveridge elasticity, the efficient tightness falls between the 1950s and the 1980s, from 1.14 down to 0.85; it moves back to 1.16 in the 1990s and 1.09 in the 2000s; and it climbs to 1.25 in the 2010s. Compared to its efficient level, actual tightness was almost always too low during the period. The only two episodes when tightness was inefficiently high were 1951–1953, during the Korea war, and 1965–1970, at the peak of the Vietnam war; tightness is virtually efficient in 2019. This implies that the US labor market is generally inefficiently slack.

Next, applying formula (5), we compute the efficient unemployment rate (figure 3, panel

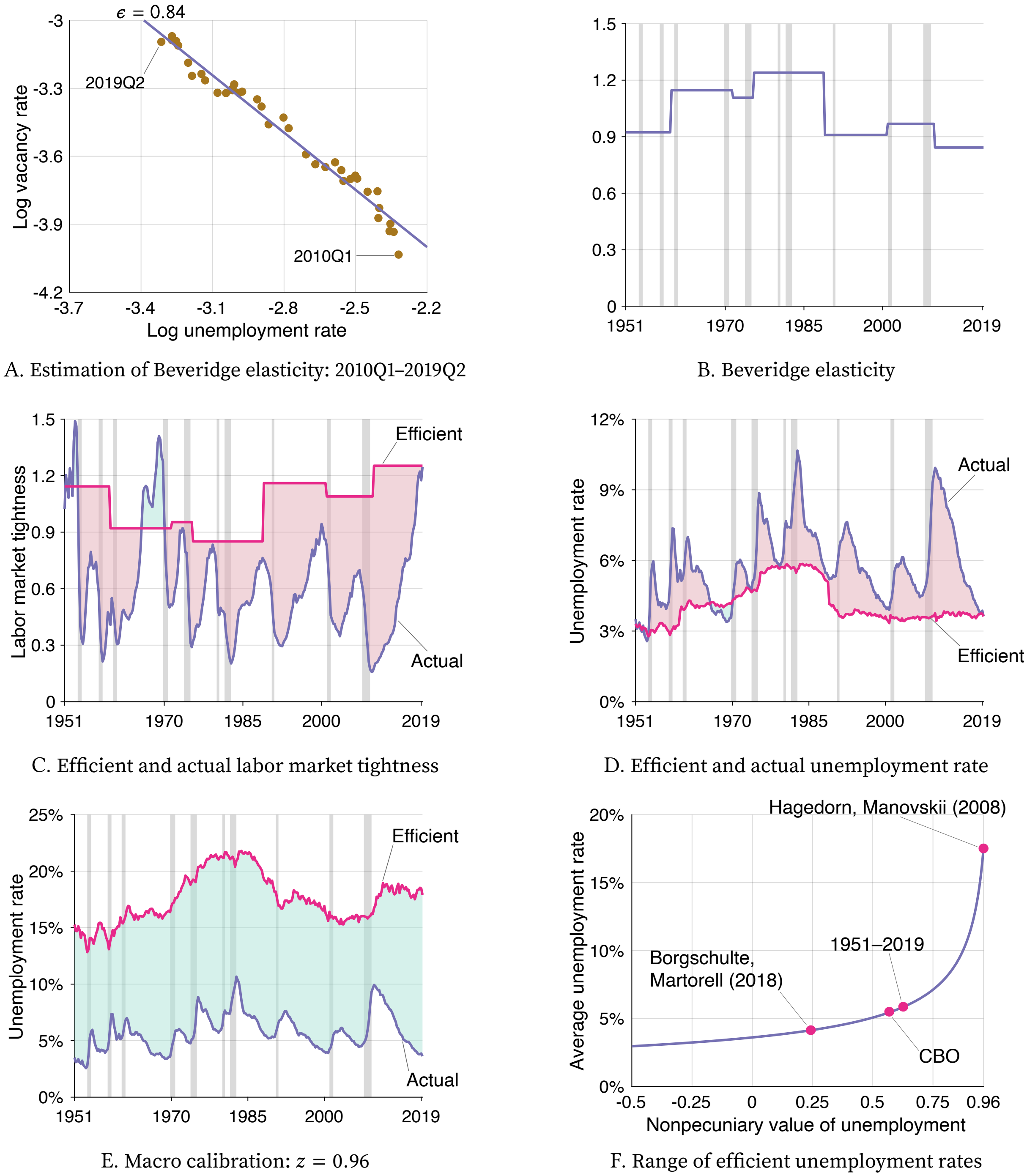

FIGURE 3. Unemployment gap in the United States, 1951Q1–2019Q2

Panels A & B: We estimate the Beveridge elasticity ϵ with OLS regressions of log vacancy rate (from figure 1, panel B) on log unemployment rate (from figure 1, panel A) for seven subperiods: 1951Q1–1959Q2, 1959Q4–1971Q1, 1971Q3–1975Q1, 1975Q3–1987Q3, 1990Q2–1999Q1, 2001Q1–2009Q3, and 2010Q1–2019Q2. Panel A illustrates, as an example, the estimation of ϵ for 2010Q1–2019Q2; the slope of the regression line gives $\epsilon = 0.84$. Panel B depicts the estimated values of ϵ for all subperiods. Panel C: Actual tightness is vacancy rate divided by unemployment rate (from figure 1). Efficient tightness is computed from (4) with $\rho = 0.72$, $z = 0.24$, and ϵ from panel B. Panel D: Actual unemployment rate comes from figure 1, panel A. Efficient unemployment rate is computed from (5) using the same statistics as efficient tightness. Panel E reproduces panel D with the calibration of the nonpecuniary value of unemployment due to Hagedorn and Manovskii (2008): $z = 0.96$. Panel F depicts the average value over 1951–2019 of the efficient unemployment rate obtained for each nonpecuniary value of unemployment $z \in [-0.5, 0.96]$. It highlights our calibration of z, due to Borgschulte and Martorell (2018): $z = 0.24$; the calibration of z from Hagedorn and Manovskii (2008): $z = 0.96$; the average US unemployment rate over 1951–2019: $u = 5.8\%$; and the average of CBO's natural unemployment rate over 1951–2019: $u = 5.5\%$. The shaded areas represent recessions, as identified by the NBER.

D). The efficient unemployment rate hovered around 3% in the 1950s, rose to 4% in the 1960s, and steadily climbed to reach 5.8% in 1980—a level it broadly maintained until 1987. The steady increase of the efficient unemployment rate from 1951 to 1980 was caused by two factors: a steady increase of the Beveridge elasticity, from 0.92 in 1951 to 1.24 in 1980 (figure 3, panel B), and a steady outward shift of the Beveridge curve (figure 1, panel C). Then, in 1988–1991, the efficient unemployment rate declined sharply to reach 3.6%. That decline was caused both by a flattening of the Beveridge curve (the Beveridge elasticity dropped from 1.24 to 0.91 in 1989), and by an inward shift of the Beveridge curve (figure 1, panel D). The efficient unemployment rate then remained very stable throughout the 1990s, 2000s, and 2010s, hovering between 3.3% and 3.9%. One surprising result is that the efficient unemployment rate did not increase in the aftermath of the 2008–2009 Great Recession, despite the outward shift of the Beveridge curve (figure 1, panel D). This is because the Beveridge curve also became flatter after 2009, which exactly offset the outward shift, leaving efficient unemployment almost unchanged by the Great Recession.

Finally, subtracting efficient unemployment rate from actual unemployment rate, we obtain the unemployment gap. Reflecting what we saw with labor market tightness, unemployment was inefficiently high during the entire period, except in 1951–1953, 1965–1970, and 2019. The mean of the actual unemployment rate over the period is 5.8%, and the mean of the efficient unemployment rate is 4.1%, so the mean unemployment gap for 1951–2019 is 1.7 percentage points. Moreover, the unemployment gap is sharply countercyclical. It is close to zero (sometimes even negative) at business-cycle peaks: for instance, -0.4 percentage points in 1953; -0.7 points in 1969; and 0 points in 1973, 1979, and 2019. And it is largely positive at business-cycle troughs: for instance, 4.3 percentage points in 1958, 3.8 points in 1975, 5.0 points in 1982, 3.9 points in 1992, and 6.2 points in 2009. Unsurprisingly, the largest unemployment gap over the period (6.2 percentage points) occurred in the wake of the Great Recession.

To summarize, the US unemployment rate appears generally inefficiently high; this inefficiency is exacerbated in slumps; and the inefficiency only disappears in deep booms. These results have implications for macro policies and macro models. First, given that the unemployment increases in recessions are inefficient, it is warranted to deploy fiscal and monetary policy in slumps to attempt to reduce unemployment. Second, given that the unemployment rate is almost always inefficient, and sometimes markedly so, it might not be productive to insist upon modeling the labor market as efficient—either by assuming that the Hosios condition holds, or by assuming competitive search (Moen 1997).

4.5. Comparison with other unemployment-gap measures

For context, we compare our measure of the unemployment gap to other existing measures.

First, our unemployment gap is higher than the gap between actual unemployment and its secular trend, because efficient unemployment is lower than trend unemployment. Indeed, Crump et al. (2019, fig. 8) estimate that trend unemployment was around 6% in the 1960s, rose to 7% in the mid-1980s, remained above 6% until 2000, and slowly declined to 4.5% over the 2001–2019 period. Hence trend unemployment is always at least 0.5 percentage points above efficient unemployment.

Second, our unemployment gap is higher than the gap between actual unemployment and the NAIRU, because efficient unemployment is lower than the NAIRU. Crump et al. (2019, fig. 8) estimate that the NAIRU fluctuated around 6% in the 1960s, climbed to 8% in the mid-1970s, remained above 6% until the mid-1980s, stayed in the 5%–6% range until 2010, before falling to 4% in 2016–2018. Thus the NAIRU is always above efficient unemployment, and follows a different pattern—but they seem to converge at the end of the sample.

Third, our unemployment gap is higher than the unemployment gap computed by the Congressional Budget Office (CBO)—which features prominently in fiscal and monetary policy discussions (Dickens 2009, p. 205). The CBO compute the unemployment gap as the distance between actual unemployment and the "natural" rate of unemployment. They construct the natural rate by blending trend and NAIRU considerations (Shackleton 2018, app. B). The CBO's natural unemployment rate started at 5.3% in 1951, consistently rose to 6.2% in 1979, and from there persistently declined to reach 4.6% in 2019.[6] The CBO's natural unemployment rate is therefore always above our efficient unemployment rate, although they were quite close in the 1980s.

4.6. Alternative calibrations the nonpecuniary value of unemployment

Given the uncertainty around the exact nonpecuniary value of unemployment, we consider alternative calibrations and explore their impact on the efficient unemployment rate.

Our calibration ($z = 0.24$) implies that the nonpecuniary value of unemployment is much lower than labor productivity. In contrast, some macro-labor studies argue that unemployed workers derive significant utility from leisure and home production. A well-known calibration, due to Hagedorn and Manovskii (2008), is $z = 0.96$. Such a calibration has a drastic impact on efficient unemployment: it implies an efficient unemployment rate always above 13%, and sometimes as high as 22%; it also implies an average unemployment gap of -11.8 percentage points (figure 3, panel E). Hence the calibration implies that actual unemployment is always much too low, even at the peak of the Great Recession—suggesting that such calibration might be implausible.

[6] See https://fred.stlouisfed.org/series/NROU.

At the other end of possible calibrations, the nonpecuniary value of unemployment might be negative. Such calibration would imply that despite free time available for leisure and home production, unemployed workers suffer from unemployment. This type of calibration may be unorthodox, but much survey evidence indicates that people incur a significant cost from unemployment: Winkelmann and Winkelmann (1998), Di Tella, MacCulloch, and Oswald (2003), Blanchflower and Oswald (2004), and Helliwell and Huang (2014) find that unemployed workers report much lower well-being than employed workers even after controlling for household income and other personal characteristics. This lower well-being seems to stem from higher anxiety, lower self-esteem, and lower life satisfaction (Darity and Goldsmith 1996; Theodossiou 1998; Krueger and Mueller 2011).

To describe the effect of the nonpecuniary value of unemployment on the efficient unemployment rate, we graph the efficient unemployment rates obtained when the nonpecuniary value of unemployment spans a plausible range: $z \in [-0.5, 0.96]$ (figure 3, panel F). For each nonpecuniary value of unemployment, the efficient unemployment rate is fairly stable over time, so we summarize its entire time series by its average value over 1951–2019. When the nonpecuniary value of unemployment is negative, the efficient unemployment rate is between 3% and 3.6%. Then when the nonpecuniary value rises from 0 to 0.5, the efficient unemployment rate increases slowly from 3.6% to 5%. Last, when the nonpecuniary value is higher than 0.5, the efficient unemployment rate grows rapidly: 6% at $z = 0.65$, 8% at $z = 0.8$, 11% at $z = 0.9$, and 17.6% when $z = 0.96$.

Finally, to provide further perspective, we infer from the calculations the nonpecuniary value of unemployment that would render US unemployment efficient on average. We find that to obtain an average efficient unemployment rate of 5.8%, which is average unemployment rate over the 1951–2019 period, the required nonpecuniary value of unemployment is $z = 0.62$. We can also do the same exercise with the CBO's natural rate of unemployment. To obtain an average efficient unemployment rate of 5.5%, which is average value of the CBO's natural unemployment rate over the 1951–2019 period, the required nonpecuniary value of unemployment is $z = 0.58$. Hence, if the nonpecuniary value of unemployment was around $z = 0.6$, the US unemployment rate would fluctuate around its efficient value—so the average unemployment gap would be zero—and the CBO's natural unemployment rate would overlap with our efficient unemployment rate.

5. Conclusion

This paper develops a method to measure the unemployment gap—the distance between actual and efficient unemployment rates. We consider a labor-market model with only one structural element: a Beveridge curve, which relates unemployment and vacancy rates. Our framework covers a broad set of modern labor market models, including the Diamond-Mortensen-Pissarides model. In this framework, we express the unemployment gap as a function of actual unemployment and vacancy rates, and three sufficient statistics: elasticity of the Beveridge curve, nonpecuniary value of unemployment, and recruiting cost.

With our formula, we measure the unemployment gap in the United States for 1951–2019. We find that the US unemployment gap is almost always positive. The gap becomes close to zero or slightly negative only in deep booms, and it is especially high in slumps. Hence, the US unemployment rate is generally inefficiently high, and such inefficiency is especially prominent in slumps. The implication is that fiscal and monetary policy could do more to stabilize the labor market over the business cycle.

We currently have good measures of unemployment and vacancies in the United States (provided by the BLS), from which we can estimate the Beveridge elasticity. To cement our measure of the unemployment gap, it would be valuable to obtain more evidence on the two other statistics. Measuring the time variations of the recruiting cost would be possible by adding new questions into JOLTS, asking firms to report the number of man-hours devoted to recruiting each month, in addition to the number of vacancies. Obtaining more estimates of the nonpecuniary value of unemployment might be feasible by applying the revealed-preference approach of Borgschulte and Martorell (2018) to other populations (their estimate comes from military personnel). Evidence on the time variations of the nonpecuniary value of unemployment would also be helpful but is less urgent—because the nonpecuniary value of unemployment only has a small effect on the efficient unemployment rate around our preferred calibration (figure 3, panel F). Our methodology could be applied to other countries as well.

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