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The Beveridge curve and equilibrium unemployment

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Abstract

The Phillips Curve is commonly relied upon to estimate the non-accelerating inflation rate of unemployment (NAIRU). However, the trade-off between inflation and unemployment has become more ambiguous, in part due to the current existence of low inflation and low unemployment. This may render NAIRU estimates less reliable. Thus, in order to gain a more accurate insight into the state of the labor market, I turn to the often-overlooked Beveridge Curve (BC), which depicts the negative relationship between the job vacancy rate (V) and the unemployment rate (U). I contribute to the literature by estimating the BC and the Job Creation Curve (JCC) for the US overall and for each US Census Region (Midwest, Northeast, South, and West) through the use of the Bureau of Labor Statistics' (BLS) Job Openings and Labor Turnover Survey (JOLTS), which covers the period from 2001-2019. Using equilibrium unemployment theory, I am able to identify equilibrium unemployment levels in both the pre- and post-recessionary periods as well as in a scenario where perfect matching efficiency (V=U) is obtained. My findings show that the US and the Midwest had the highest equilibrium unemployment estimates under the prevailing conditions in the post-recessionary period at 5.6%, while the South had the lowest, at 5.2%. Conversely, in a world of perfect matching efficiency (where V = U), the steady-state equilibrium estimates are much lower, ranging from 4.1% to 4.3%.

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1. Introduction

The Beveridge Curve (BC) describes the negative relationship between the job vacancy rate and the unemployment rate (Beveridge 1944) and is often overlooked when analyzing labor market conditions (Blanchard and Diamond 1989). Former Federal Reserve Chairwoman Janet Yellen said in a review of Blanchard and Diamond's work that the BC was "the neglected stepsister of macroeconomics" (Lubik and Rhodes 2014).

In the current environment of low inflation and low unemployment, the Phillips Curve has been flat, rendering Non-Accelerating Inflation Rate of Unemployment (NAIRU) estimates derived from it less useful. The BC can serve as a more useful alternative to the flat Phillips Curve (Consolo and da Silva 2019), as it is not restricted by the persistence of low inflation and low unemployment. I use the neglected BC to derive equilibrium unemployment estimates and consider the very interesting period of 2001-2019, the entire period for which data is available.

Despite more recent papers that have taken advantage of the Bureau of Labor Statistics' (BLS) new Job Openings and Labor Turnover Survey (JOLTS), there is a lack of research on the BC's usefulness in estimating equilibrium unemployment, especially at the regional level. Equilibrium estimates can be found at the intersection of the Job Creation Curve (JCC) and the BC. The JCC represents the creation of job vacancies by firms and can be roughly thought of as an aggregate labor demand curve (Daly *et al.* 2011). I estimate equilibrium unemployment under matching efficiency and under the prevailing labor market conditions in both the pre- and post-recessionary periods for the four US Census regions and the US overall. Considering regional-level data allows me to account for variations that would be overlooked in a country-wide analysis (Tasci and Treanor 2018; Valletta 2005; Wall and Zoega 2002).

My findings show that under perfect matching efficiency in a tight labor market (where there is one job vacancy for each unemployed individual), the equilibrium unemployment rate would be 4.1% for the Northeast, and 4.3% for each of the other three Census regions and the US overall. As I will show, the timing of structural breaks plays a role in the ability of unemployment to revert to its equilibrium. Structural breaks explain the statistical existence of a fundamental change in the relationship between unemployment and job vacancies. As a result, the equilibrium estimates in the post-recessionary period are much larger, ranging from a high of 6% in the West to a low of 5.4% in the Midwest. Notably, these estimates are higher than those of the Congressional Budget Office (CBO 2018).

The remainder of this paper is as follows. Section 2 explains the theoretical framework. Section 3 discusses the data and econometric methods, section 4 provides a discussion of the results, and section 5 concludes.

2. Theoretical Framework

The BC is based upon a Cobb-Douglas matching function with constant returns to scale and is convex to the origin (Lubik 2013). The matching function can be defined as follows:

$$M = m(U,V) \quad (1)$$

Where U is unemployment, V is vacancies and M represents the number of matches between firms with vacancies and workers seeking employment. There is a negative relationship between the unemployment rate and the job vacancy rate (Baek and Raines 2016), which the BC visually shows (a theoretical BC is depicted in figure 1). The notion of a matching function makes sense, given that matches or "pairs" are made between unemployed workers and firms with vacancies. At any given time, the matching function explains the number of jobs created as a function of those seeking jobs, and the number of firms seeking workers (Pissarides 2000).

Perfect matching efficiency between firms with job vacancies and individuals seeking jobs is achieved when the Vacancy (V)/Unemployment (U) ratio = 1 = θ. θ is the slope of the JCC and represents labor market tightness (a tight labor market is typically synonymous with low unemployment rates). The JCC is positively sloped (see figure 1), as vacancies are easier to fill when there are more unemployed individuals to choose from. As the hiring pool grows, offering things such as more competitive wages are not necessary, so hiring costs decline and more vacancies are posted (Elsby *et al.* 2015).

The rate at which vacancies do get filled can be defined as a function of the JCC condition, where the slope is $\frac{V}{U}$:

$$JCC = \theta = \frac{V}{U} \tag{2}$$

Put differently, and based on the matching function and the JCC, the rate at which vacant jobs get filled is:

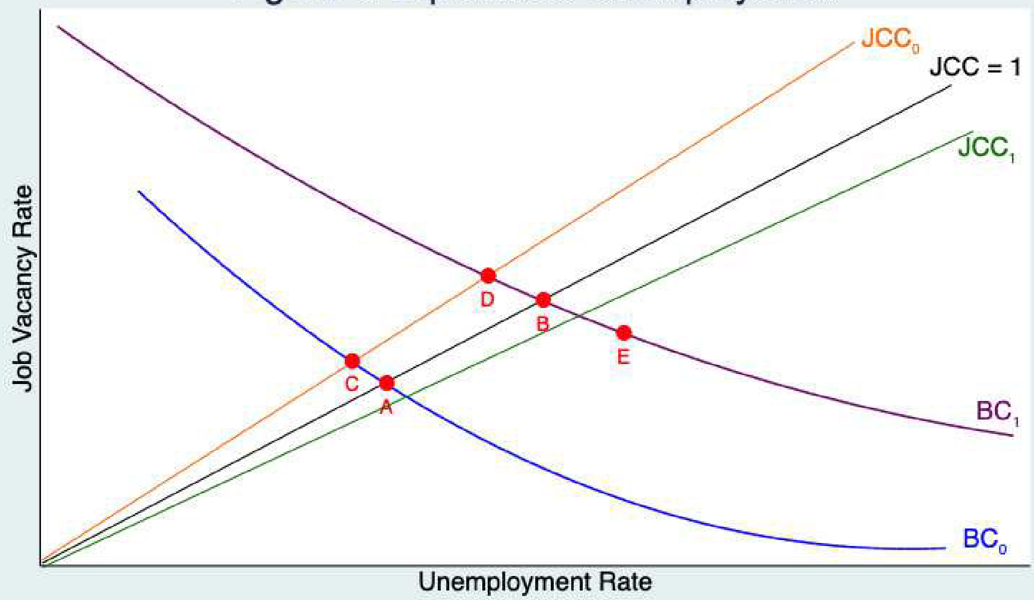
$$q(\theta) = m\left(\frac{u}{v}, 1\right) \tag{3}$$

The probability that a vacant job and an unemployed worker will be matched in a given time frame is $q(\theta)$.

Under a tight and efficient labor market, the slope of the JCC would be equal to one, as there would be one job vacancy for each unemployed individual. As such, the JCC would be represented by a 45-degree line extending from the origin (see figure 1). Here, equilibrium unemployment under matching efficiency can be represented by point A for given BC position BC_0. If the BC was further from the origin (representing a less efficient labor market), then an equilibrium unemployment level can be gleaned from point B.

In reality, the JCC is seldom equivalent to one, representing an imperfect labor market with frictions that impact how firms are able to fill their vacancies and how job seekers are able to find a firm that is a good match for their skills. Complicating matters further, establishing an equilibrium when θ is very small can be challenging (Cardullo 2009). Consider two separate examples. In the first case (JCC_0), θ is greater than one, indicating a strong labor market where there are more vacancies than jobless individuals. JCC_0's intersection with BC_0 (point C) or BC_1 (point D) represents the equilibrium unemployment rate under the prevailing conditions. Consider this position a steady state with imperfect matching. Alternatively, the JCC can be less than one, where the unemployment rate exceeds the job vacancy rate. This case is represented by JCC_1, and the equilibrium steady-state can be found at E. Notice, that JCC_1 and BC_0 do not intersect as there has been a change in the matching function which has caused a shift of both the JCC (from JCC_0 to JCC_1) and the BC (from BC_0 to BC_1) .

Figure 1: Equilibrium Unemployment



A represents ideal equilibrium under matching efficiency. B represents a new equilibrium once the BC has shifted out.
C represents equilibrium under initial prevailing conditions. D shows equilibrium after a BC shift.
E represents the new equilibrium once JC & BCC have both shifted.

Shifts of the BC away from the origin (see figure 1, where BC_0 shifts to BC_1) reflect a decrease in matching efficiency (more trouble matching firms and workers) which can manifest itself in either structural or frictional unemployment. Both types of unemployment of course, raise the natural rate of unemployment. On the other hand, it is possible for shifts to occur along the BC, but these movements are more attributable to cyclical factors such as changes in the business cycle (Daly *et al.* 2012). Shifts can occur in the BC and/or the JCC and at different times (Daly *et al.* 2011). The timing and reasoning for these shifts is something I make a preliminary attempt at unraveling. Debates remain over the distinctions between movements of the BC and movements along the BC (ex: Wall and Zoega 2002; Blanchard and Diamond 1989). This distinction is not something I attempt to clarify.

The BC and JCC can shift for many reasons. Shifts of either curve do not automatically imply a simultaneous shift of the other curve. In general, shifts in the JCC tend to occur less frequently because, in the long run, job creation tends to be static. For example, a lower level of aggregate demand can shift the JCC, but, like most JCC shifts, the impact tends to be transitory (Daly *et al.* 2011). Increases in the duration of unemployment insurance, increases in the rates of layoffs, and increases in skill or geographical mismatch can shift the BC away from the origin. These BC impacts tend to be permanent (Daly *et al.* 2011). Other factors, such as the selectivity of hiring job candidates and the intensity of recruitment can also alter the BC, but not the JCC (Faberman, 2014; Davis *et al.* 2010).

3. Data and Econometric Methods

3.1 Data

My geographical focus is the US as a whole, followed by the four Census regions as defined by the US Census Bureau (Midwest, Northeast, South, and West). From the BLS's Local Area

Unemployment Statistics (LAUS), I gather headline employment or "U3," which is seasonally adjusted and collected on a monthly basis from 2001-2019 (BLS 2019). The BLS' JOLTS provides the seasonally adjusted job vacancy rate. According to the BLS, the job vacancy or job openings rate can be defined as follows, "The number of job openings on the last business day of the month divided by the sum of the number of employees who worked during or received pay for the period that includes the 12th of the month and the number of job openings on the last business day of the month" (BLS 2019). On average, the unemployment rate was 6% over the period for the US overall and the job vacancy rate averaged 3.11%. Regional averages are comparable.

3.2 Econometric Methods

I carry out the following analysis at the regional level and for the US as a whole. I test to see if a structural break has occurred in the BC, following Barlevy (2011) and Lubik (2013). If there is a structural break, then the BC has shifted (Bova *et al.* 2016). On its own, the appearance of a graphical shift of the BC does not necessarily imply that a structural break has occurred.

Structural breaks help to explain fundamental changes in the matching function that will impact labor market performance, either permanently or temporarily. I employ a Supremum Wald test to determine if there has been a structural break at an unknown date. This allows me to consider the possibility that a structural break may not have occurred in the exact moments of the 2007-2009 recession. After all, the labor market is known to be highly flexible (Elsby *et al.* 2013). The null hypothesis is that a structural break has not occurred. The Wald test statistic is reviewed for each potential break date (Perron 2018; Perron 2005). I repeat this process to determine if/when a structural break has occurred in the JCC.

There are many potential reasons to explain why a structural break implies that the BC has shifted. First, visual shifts of the BC can be hard to confirm, especially because points between different BCs may appear to overlap. This makes an empirical test crucial (Bova *et al.* 2016). When the relationship between the matching of vacancies and the unemployed has changed in some fundamental way, the BC will shift. Shifts of the BC towards the origin indicate an improvement in matching efficiency (decreased mismatch – firms and workers are able to find each other easier) while shifts away from the origin indicate a decline in matching efficiency (increased mismatch – workers find it harder to match with firms posting vacancies). Mismatch may be skill-based or geographical (Romero 2018). For example, Sahin et al. (2014) found that mismatch among industries and occupations accounted for up to a third of the increase in the unemployment rate between 2006 and 2009. Barnichon and Figura (2015) found that the dispersion in the labor market (the extent to which certain labor markets perform worse than others) had increased between 2008 and 2012, accounting for 1/3 of the decline in matching efficiency over that period. Matching efficiency has consistently declined since the 1950s, despite periods of low unemployment, which Benati and Lubik (2012) attributed to technological change in the labor market, which has benefited skilled and educated workers the most.

4. Results

First, I test for a structural break in the matching function for each of the regions individually and for the US overall to determine if there has been a shift in the BC. I find that the shifts occurred between February 2009 and September 2009 (see table I). Shifts in the BC often manifest themselves as transitions between high and low performing labor markets (Lubik *et al.* 2016). My findings are consistent with that of Barlevy (2011) who found a breakdown in the forecast of the BC in August of 2009 and attributed this to a change in the matching function. Similarly, Figura and Ratner (2015) allowed for a break in early 2009.

Instinct would be to assume that the BC has shifted towards the origin, since the US economy was experiencing the longest expansion on record during the post-recessionary period, according to the National Bureau of Economic Research (2019). However, the BC has shifted away from the origin, as confirmed by structural breaks (see figure 2). My findings of a rightward shift of the BC are consistent with the findings of Daly *et al.* (2011), Hobijn and Sahin (2013), Diamond and Sahin (2014), and Baek and Raines (2016). A shift of the BC away from the origin represents a decrease in matching efficiency (Lubik 2013). In the current low inflation and low unemployment environment, the BC's position can help to explain a labor market that is tight, but less efficient. The matching function has changed as there has been a breakdown in the matching process, as evidenced by structural breaks. The labor market is simply not as efficient as it once was at pairing unemployed workers with job vacancies. Daly *et al.* (2012) has suggested that factors such as the duration and generosity of unemployment insurance may play a role in this decrease in efficiency. Here, the BC's superiority over the Phillips Curve shines through, as the shift away from the origin helps to explain why wage growth has been muted and why the Phillips Curve has been flat, as a decline in the efficiency of the job market tends to dampen wages (Consolo and da Silva 2019).

Table I: BC Structural Break Test using Wald Test Statistic

	Break Date	**Pre-Recession**	**Post-Recession**	**Wald Test Statistic**
United States	2009m2	2001m1-2009m1	2009m2-2019m10	1196.9159***
Midwest	2009m2	2001m1-2009m1	2009m2-2019m10	1262.2679***
Northeast	2009m2	2001m1-2009m1	2009m2-2019m10	788.2718***
South	2009m5	2001m1-2009m4	2009m5-2019m10	849.5429***
West	2009m9	2001m1-2009m8	2009m8-2019m10	548.9044***

Break date indicates when the BC shifted away from the origin.

I then repeat the structural break process for each geographical unit to determine if there has been a shift in the JCC (see table II). I find that the shifts in the JCC occurred much later than the BC shifts. Structural breaks tend to occur when matching efficiency remains low for an extended period of time (Lubik 2013), as the rate of adjustment of the US labor market is fairly high (ex: firms can temporarily reduce employee hours rather than laying off workers) (Elsby *et al.* 2013). This helps to explain the delayed shift of the JCC relative to the BC even after the unemployment rate peaked at 10% in the US near the end of 2009. Despite the enduring expansion, there has not been a substantial change in the matching function since the post-recessionary period, as the data does not support a third structural break.

One possible explanation for the various break dates may be the intensity of long-term unemployment. Later break dates are suggestive of less long-term unemployment. With less long-term unemployment, the economy is able to rebound faster (Figura and Ratner 2015). The long-term unemployed often lose valuable workplace skills, creating additional skill mismatch. What's more, long-term unemployment may result in labor force dropout, which can add a hysteresis component to the natural rate (Blanchard 2018), resulting in a higher rate, which may persist indefinitely.

Table II: JCC Structural Break Test using Wald Test Statistic

	Break Date	Pre-Recession	Post-Recession	Wald Test Statistic
United States	2010m4	2001m1-2010m3	2010m4-2019m10	804.1962***
Midwest	2011m1	2001m1-2010m12	2011m1-2019m10	520.3491***
Northeast	2010m4	2001m1-2010m3	2010m4-2019m10	606.3975***
South	2010m7	2001m1-2010m6	2010m7-2019m10	561.7903***
West	2010m1	2001m1-2009m12	2010m1-2019m10	700.8255***

Break date indicates when the JCC shifted closer to the 45-degree line, representing a “tighter” labor market.

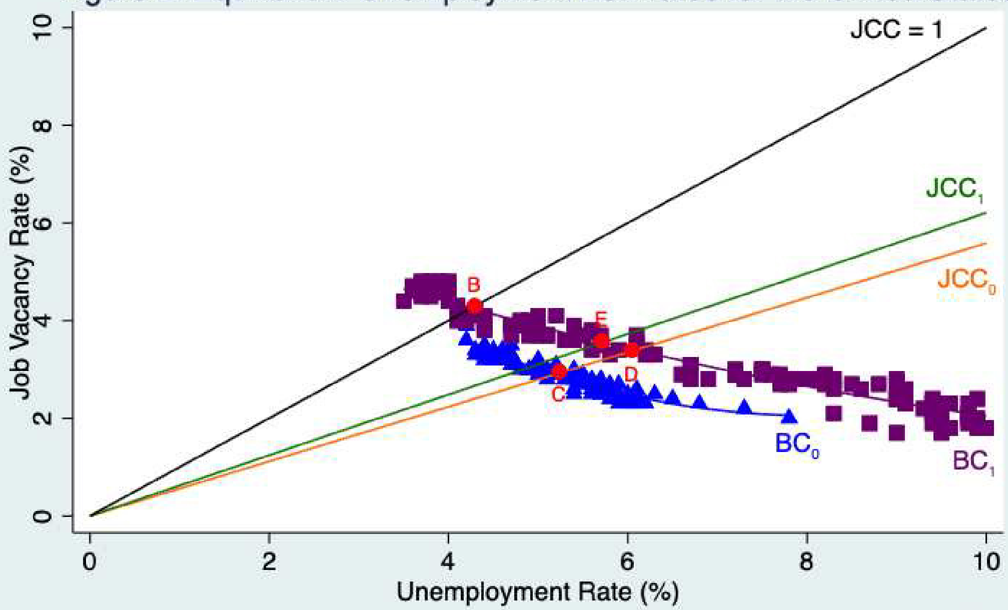
Table III shows equilibrium estimates where the slope of the JCC is equal to one as well as equilibrium estimates under the prevailing conditions (in both the pre- and post- recessionary periods) for each region and the US. Between the pre- and post- recessionary periods, there has been a seemingly permanent increase in the steady-state equilibrium, despite historic low unemployment rates. For example, under perfect matching efficiency, the equilibrium unemployment rate would be 4.3% in the US. In the pre-recessionary period this equilibrium was 6% and has only fallen slightly to 5.7% in the post-recessionary period. This implies a fundamental change in the matching function. In other words, the process of matching between firms and job seekers is not the same in the pre- and post- recessionary periods.

Table III: BC and JCC Intersections

	Matching Efficiency: θ = 1		Pre-Recessionary Period		Post-Recessionary Period
	A	B	C	D	E
United States	-	4.30%	5.20%	6.00%	5.70%
Midwest	-	4.30%	5.40%	6.40%	5.40%
Northeast	3.80%	4.10%	4.90%	5.80%	5.70%
South	3.90%	4.30%	5.10%	6.00%	5.70%
West	-	4.30%	5.60%	6.50%	6.00%

BC and JCC intersections represent equilibrium unemployment estimates under different scenarios. A matching efficiency equal to one represents a case where there is one job vacancy for each unemployed individual. The pre- and post- recessionary periods represent equilibrium unemployment under the prevailing conditions in that period. A represents the intersection of BC_0 and a JCC equal to 1 (indicating matching efficiency). B represents the new equilibrium, following the shift of the BC, at the intersection of BC_1 and a JCC equal to 1. C represents the intersection of BC_0 and JCC_0, representing initial labor market conditions. D represents the intersection of JCC_0 with BC_1, marking the moment at which the BC has shifted but the JCC has not. Finally, E represents the point where both the BC and the JCC have shifted, at BC_1 and JCC_1.

Figure 2: Equilibrium Unemployment Estimates for the United States



No A (equilibrium under matching efficiency) was found. B (4.3%) shows ideal equilibrium after BC shift. C shows initial equilibrium conditions (5.2%). D shows equilibrium conditions after BC shift (6%). E shows prevailing conditions after BC & JCC shifts (5.7%).

Even though the BC and JCC share the same components, structural breaks do not necessarily occur at the same time for both functions. This can be attributable to several reasons. The JCC tends to break later because in the long run, job creation is not permanently altered (Daly *et al.* 2011). On the other hand, shifts of the BC tend to be more permanent, and driven by factors such as increases in mismatch. Increases in mismatch and the rate of layoffs can drive the BC away from the origin permanently but will only impact the JCC in the short run (Daly *et al. 2011)*. Daly *et al.* (2011) found that increases in the duration of unemployment insurance could shift the BC further from the origin but would not impact the JCC in the long run. In the short run, unemployment insurance can impact the JCC by increasing the reservation wage (why take a job for minimum wage if you make more on unemployment insurance?) and decreasing job creation. The only factor that can impact the JCC but not the BC is lower aggregate demand. Lower aggregate demand can reduce job creation, though the impact is usually transitory (Daly *et al.* 2011).

One of the largest, but most elusive factors that can impact search and matching is uncertainty. For example, if firms are uncertain about the political environment, they may still choose to post the same number of vacancies (so the JCC would not change position) but they may be more selective in hiring, which would cause the BC to shift away from the origin (Daly *et al.* 2011). This reflects a change in recruiting intensity, which is essentially the effort that firms exert to hire candidates, and can range from offering attractive pay and benefits, to providing sign-on bonuses (Davis *et al.* 2010). Faberman (2014) found that these changes in recruiting intensity can help to explain breakdowns in the matching function.

In the post-recessionary period, the Midwest had the lowest equilibrium rate of 5.4%. Notably, the Midwest experienced the greatest change in θ between the two periods and was the last to experience a structural break in the JCC in 2011. This is suggestive of the idea that both the change in the strength of the labor market and the timing of structural breaks (representing a fundamental change in how matches are made) plays a role in determining the speed at which the matching function adjusts and thus how the reversion to the equilibrium occurs. This consideration opens the door for more research on how the timing of structural breaks impacts the equilibrium levels found at the intersection of the JCC and the BC.

5. Conclusion

All in all, the BC is an important, yet often overlooked macroeconomic paradigm. When the reliability and precision of the Phillips Curve is in doubt, the BC can serve as a useful alternative to conceptualize equilibrium unemployment in both a tight and efficient labor market and under prevailing labor market conditions in both the pre- and post- recessionary periods. My findings of a relatively high level of equilibrium unemployment in the post-recessionary period (estimates range from 5.4%-6%) suggest that the labor market could get stronger still without the risk of significant inflationary pressures. These prevailing equilibrium conditions are notably higher than the equilibrium found under matching efficiency, where levels would be much lower, between 4.1% and 4.3%. The historic strength ("tightness") of the labor market is evidenced by θ, while the shift of the BC away from the origin helps to explain why muted wage growth has become the norm, and why the Phillips Curve has been flat, as a decrease in the efficiency of the labor market tends to restrain wage growth. Policymakers should consider the notion that, until the matching function improves, and the BC reverts closer to the origin, unemployment levels can remain low without the risk of substantial wage and price pressures.

More research is needed to understand how the BC can serve as a useful alternative to the Phillips Curve and how theoretical conceptualizations of equilibrium unemployment may be applied to analyze the state of this unusual labor market. Furthermore, more research is needed to understand the strength of the structural break tests. As Ventosa-Santaularia and Vera-Valdes (2008) noted, determining structural breaks is often elusive. For instance, is the structural break capturing a true break or simply random walk behavior?

Even with the historic strength of the labor market, the matching function breakdown shows the mismatch of pairing job vacancies with unemployed workers. Research is needed to pinpoint why this mismatch is occurring. In the era of the internet, one would expect that finding matches would be both simpler and more efficient. The data suggests that this has not been the case. Understanding how shifts of the BC and shifts along the BC should be interpreted could help to reveal the mechanics of this breakdown. Considering state-level data could also add value.

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