The German Beveridge curve in light of the shortness of skilled labour

Friedrich L. Sell und Jürgen Stiefl

Authors’ affiliation:

Prof. em. Dr. Friedrich L. Sell (corresponding author)
Tel. 089-69342656. E-Mail: Friedrich.Sell@unibw.de.

ORCID https://orcid.org/0000-0001-7123-0178

ORCID https://orcid.org/0000-0003-2562-7080.

Abstract

The Beveridge curve and its inward or outward shifts are legend in labour market economics. Inward shifts in particular have been shown to reflect, for example, the success of the “Hartz reforms” after 2003-2005, reforms which allegedly have improved the matching efficiency on the German labour market. More recently (not later than since 2020), the German labour market is seriously affected by a “systemic” shortness of skilled labour. The latter occurs when we observe both a rising unemployment rate among the qualified work force and an increasing vacancy rate with regard to skilled labour. In this paper, we develop in three alternative writings the functional form of the Beveridge curve and its corollary, the corresponding econometric estimation equation. This enables us to empirically identify the determinants of the German Beveridge curve (2006-2023). We find evidence for the presumption that recently the German Beveridge curve shifts outwards, most likely as a consequence of the systemic shortness of skilled labour.

Keywords: labour market, shortness of skilled labour, Beveridge curves, Germany

JEL Classification: E24, J63, J64

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1. Introduction: a short narrative of the German labour market (2006-2023)

For the first time since 2003, Germany's real GDP threatens to decline in 2024 for the second time in two consecutive years (Huchzermeier et al. 2024: 12). Economists tend to call this a recession. In 2003, and in the years that followed, the Schröder government at the time reacted with far-reaching labour market reforms (Hildebrand et al. 2024: 7). However, Germany’s former chancellor (1998-2005) Gerhard Schröder committed a severe economic error of reasoning in 2005 (Sell 2018: 35): instead of waiting a bit for the positive effects which the promising “Hartz-reforms” (2003-2005) were to have on the German labour market, he took the lost elections in the state of Nordrhein-Westfalia in spring of 2005 as a pretext to “organize” early general elections on the federal level in autumn of 2005. Due to the lack of visible positive effects on the German labour market at the time his party and the green coalition party lost the elections in September of 2005 with a crash. Already in the beginning of 2006 – regular general elections would have been scheduled in September – positive repercussions of the “Hartz-reforms” on (increasing) employment and (decreasing) unemployment, accompanied by a decreasing labour market rigidity, could be observed (Seele 2023: 4). Recent research, however, has demonstrated that “direct intermediation activities of the Federal Employment Agency did not contribute to the decline of unemployment in Germany. By contrast, improved activation of unemployed workers reduced unemployed by 0.8 percentage points” (Merkl and Sauerbier 2022: 24). After all, “better activation policies through the PEA (public employment agency) lead to a stronger use of the (more efficient) private market” (ibid: 24). Moreover, these activating effects lasted at least until 2014 (Bräuninger et al. 2014; Seele 2023: 4). The question arises: what is the actual contribution of the contemporary recession to the development of the German labour market?

In the time span between 2015 and 2023, at least three major occurrences affected the German labour market: firstly, the introduction of a general statutory minimum wage rate on January 1, 2015; secondly, a massive asylum immigration since September 2015 which continued in 2016 only to be slowed in 2017 and thirdly an increasing shortness of labour and of skilled labour in particular registered nationwide no later than since 2020.

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1 We appreciate the most valuable comments and suggestions of two anonymous referees made on an earlier version of this paper. We also would like to thank Christoph Ostermair for his excellent advice.
2 “And thereby shifted the aggregate Beveridge Curve inwards” (ibid: 24). In the next section we will thoroughly inspect this curve.
3 We will refrain from reporting the large existing literature on the subject. A perfect overview is provided by Merkl and Sauerbier (2022).
4 However, in 2023, the figures have gone strongly up again.
The minimum wage rate started with a level of Euro 8.50 p. h. It was raised annually following suggestions of a mixed minimum wage commission. Only in 2022, the new federal government ignored the consultancy of the minimum wage commission and elevated the minimum wage to Euro 12. It reached a level of Euro 12.41 on January 1, 2024. Contrary to the fears of well-known German economists (Knabe et al. 2021: 933-936) negative employment effects have hardly been demonstrated to date.

It is difficult to assess the labour market effects of asylum immigration: it is known that the participation rate, i.e., the proportion of employed refugees of working age between 15 and 64, is only 55% after 8 years, i.e., in 2023. “To date, 45 percent of those who fled to Germany in 2015 have not yet entered the labour market. According to an IAB (Institut für Arbeitsmarkt- und Berufsforschung) survey, women in particular are significantly less likely to be employed. While about 60 percent of refugee men work, it is ... among women, only 25 to 30 percent. Some refugees are in language or integration courses, while others are in further education, training or parental leave and maternity leave" (Bauer 2023).

It is about time to put our many observations into a comprehensive analytical framework: To characterize disequilibrium in the labour market, labour market economics primarily uses two ratios: the unemployment rate and the vacancy rate. As Figure 1 shows, the German vacancy rate has been rising for a long time almost in line with the trend, while the German unemployment rate has been falling in a mirror image at least until the end of 2019. This development was interrupted by the severe economic slumps that were (and in some cases still are) due to the Corona pandemic, the energy crisis, and the economic consequences of interrupted supply chains, so that there was an increase in the unemployment rate in 2020 and 2021 (see Figure 1). Since then, the unemployment rate is reluctant to further decline. The vacancy rate has reached a temporary peak in the mid of 2022 and is about stable since then. Strating in the end of 2021, the vacancy rate is constantly above the unemployment rate. Thus, the period from 2006 to 2023 on the German labour market is roughly divided into two subsections: 2006-2019 and 2020 to the present day.

Figure 1 tends to confirm at first sight Merkl's and Sauerbier's findings (2022: 7): “In … times of labour market booms (associated with lower unemployment) firms post a larger fraction of vacancies” (ibid). But this observation is nowadays seemingly asymmetric: higher vacancy

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5 It is not known, for example, whether the 60 percent of the refugee men who work had previously applied for advertised vacancies, i.e. reduced the vacancy rate c.p. through their employment, and also not whether the residual 40% are entitled to work/have registered as unemployed.
rates can go along with a sluggish labour market. How can we explain this phenomenon? Can the Beveridge curve capture these newly observed effects?

The rest of this article is structured as follows: In the next second section, we develop step by step the Beveridge curve following Pissarides (1985) and Mortensen/Pissarides (1994). In the third section, we will present the new conditions of a “systemic” shortness of skilled labour in Germany. An econometric investigation of the German Beveridge curve (2006-2023) follows in the 4th section. In the 5th section we discuss some economic policy recommendations. The sixth section offers our summary of findings, while the literature section and four appendixes close our exposition.

![Figure 1: German vacancy rates and unemployment rates 2006 - 2023](image)

**Sources:** EUROSTAT; own calculations

2. **The pillars of the Beveridge curve**

In order to reduce the number of vacancies, an efficient placement policy on the labour market is needed. It can be assumed that there is a (positive) correlation between the chances of gaining a job \(\eta\) on the labour market on the one hand and the number of vacancies \(V\) on the other.

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6 While we base Figure 1 above on the European-harmonised data from EUROSTAT, the sometimes-differing data reported in print media such as the NZZ, SZ, FAZ etc. are based on statistics from the German Federal Employment Office (GFEO).

7 In the following, we neglect the subject of "reporting rates" which result from the ratio of reported vacancies to actual vacancies: the reported vacancies reflect only a fraction of the actual vacancies. It tends to be the case that the higher the level of requirements, the lower the reporting rate (Burstede et al. 2020: 18).
This relationship is exemplified by the "matching function" (cf. Mortensen/Pissarides 1994 and Pissarides 1985):

\[ \eta = g(\theta), \text{ with } \theta = \frac{V}{U} \]

With \( \eta \) = probability that unemployed persons will be hired on the 1st labour market within a single period; \( V \) = number of vacancies; \( U \) = number of unemployed; \( \theta = V/U \). The stylized properties of the matching function are:

\[ g' > 0; \quad g'' \leq 0 \]

As an example, let's use the following non-linear function: \( \eta_0 \) is a "base probability" of being successfully placed. This probability varies from country to country and is likely to be higher the better the institutional setting of the labour market agency involved. In principle, one may specify the matching function in two variants, one in a restricted and a second in an unrestricted version:

With \( \alpha = 0.5 \) (restricted case A): \( \eta = \eta_0 \left( \frac{V}{U} \right)^{0.5} \) or \( \eta = \eta_0 \theta^{0.5} \)

With \( 0 < \alpha < 1 \) (unrestricted case B): \( \eta = \eta_0 \left( \frac{V}{U} \right)^{\alpha} \) or \( \eta = \eta_0 \theta^{\alpha} \)

Figure 2: The stylized form of the matching function

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Source: own compilation

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8 For a degressive course, it is sufficient to assume that alpha is greater than zero but less than one. However, since the lower and upper bounds are equally probable according to the principle of insufficient reason, the middle of the interval (0.5) is a reasonable assumption.
The matching function increases (Figure 2) as a function of $\theta = V/U$, but with a decreasing slope. We therefore assume that a decreasing number of unemployed, given the number of vacancies, has just as positive an effect on the chances of finding a job as an increasing number of vacancies, given the number of unemployed.

This leads to the obvious question of the relationship between the vacancy rate $v$ (number of vacancies in relation to the labour force) on the one hand and the unemployment rate $u$ (number of unemployed in relation to the labour force) on the other hand. This relationship is investigated by the Beveridge curve, named after the British economist William Henry Beveridge (1879-1963). In the following, we concentrate on the unrestricted case from above. The formal shape of the "Beveridge curve" is then (a complete derivation of the differential quotients can be found in the mathematical appendix 1):

$$v = \left(\frac{s}{\eta_0} (1 - u)\right)^{1/\alpha} u^{-\frac{\alpha-1}{\alpha}},$$

with the features: $\frac{\delta v}{\delta u} < 0$ for $u < 1$ and $\frac{\delta^2 v}{\delta u^2} > 0$.

The Beveridge curve therefore has a negative slope, with a decreasing curvature. We observe the following effects as a consequence of parameter variations:

$$\frac{\delta v}{\delta s} > 0 \text{ for } u < 1$$

$$\frac{\delta v}{\delta \eta_0} < 0 \text{ for } u < 1$$

An increased (decreased) probability of dismissal (labour market re-entry) therefore shifts the Beveridge curve outwards (inwards).

In logarithmic notation, the (unrestricted) Beveridge curve reads:

$$\ln v = \frac{1}{\alpha} \ln \left(\frac{s}{\eta_0}\right) + \frac{1}{\alpha} \ln (1 - u) + \frac{\alpha - 1}{\alpha} \ln u$$

With $\frac{\alpha - 1}{\alpha} < 0$ as $0 < \alpha < 1$.

As can be seen in Figure 3 below, the Beveridge curve is convex to the origin, with points D, A and B lying on a source beam whose slope, $u/v$, represents the ratio of vacancies to the number of unemployed, $V/U$. Since it is a 45° straight line, $u = v$ always applies on this line, so...
here the job offers and the demand for jobs correspond to each other, assuming that the unemployed are in principle job seekers.

The extent of the frictional-structural component of unemployment can be expressed by the spatial location of the Beveridge curve. Notice that here there are two key parameters, $s$, and $\eta_0$ involved. While the first one stands for the probability to lose one’s job, the second represents some basic likelihood to re-enter the first labour market after one period of unemployment. Both are intimately linked to the issue of shortness of skilled labour (SOSL)\textsuperscript{9}:

(i) When we deal with “transitory” or likewise “traditional” SOSL, firms will aim to keep the skilled part of the plant even in a recession (so that $s$ turns out to be rather low), job seekers with good qualifications will find it relatively easy to get back into a job (so that $\eta_0$ turns out to be rather high) even if the upswing of the economy is yet to come. Both effects then work together and tend to make the shift parameter $\frac{s}{\eta_0}$ comparatively low resulting in an \textit{inward} shift of the Beveridge curve.

(ii) However, when we deal with “systemic” SOSL things work right into the opposite direction: even qualified people face a high probability to be dismissed in firms which undergo a process of systemic transformation (so that $s$ turns out to be rather high), job seekers with good, but increasingly unwarranted qualifications will find it relatively hard to get back into a job (so that $\eta_0$ turns out to be rather low). Both effects then work together and tend to make the shift parameter $\frac{s}{\eta_0}$ comparatively high resulting in an \textit{outward} shift of the Beveridge curve.

More explanations of a “systemic” shortness of skilled labour will be given in more detail in section 3.

Of course, the Beveridge curve can shift for a variety of reasons and not because of a shortness of skilled labour alone. Examples include a decline in the \textbf{matching efficiency}, \textbf{changes in demographic composition}, an increase in \textbf{on-the-job search}, and a rise in \textbf{job turnover}. Each of these reasons can be regarded in relation to a shortness of skilled labour: The correlation between the (transitory or systemic) shortage of skilled workers on the one hand and a declining

\textsuperscript{9} A "shortage of skilled workers" occurs when the demand for labour exceeds the supply of labour, i.e., when there are more vacancies than suitably qualified unemployed at any given time. The "skilled worker gap", on the other hand, indicates the number of qualified workers who are missing in an occupation in order to be able to fill all vacancies in the region under consideration. The larger the skills gap, the more jobs are likely to remain unfilled (Burstedde et al. 2020: 31).
matching efficiency on the other hand is simple: if a position is advertised that can be filled immediately with a skilled worker, the matching efficiency (shortness of skilled labour) is equal to one (zero), if it cannot be filled even in the long term, it is zero (one). The more significant a shortness of (transitory or systemic) skilled labour force is, the lower will be the matching efficiency, ceteris paribus. It is the demographic transition which determines changes in the demographic composition: a growing cohort of retired in conjunction with a shrinking cohort of an active population will necessarily result in a (rising) shortness of (transitory or systemic) skilled labour, as long as the production technologies do not change substantially. On-the-job-search initiatives will decline (rise) on the background of a transitory (systemic) shortness of skilled labour because qualified job seekers will find it (less) easier or likewise (less fast) faster to be hired by firms. Job turnover should be reduced (increased) as well in an economy facing the transitory (systemic) shortness of skilled labour: firms have a (weak) strong incentive to bind the personal to one’s own company.

What matters here is that neither matching efficiency, nor demographic composition, on-the-job search, or job turnover experienced such a significant change in the last years in Germany as the shortness of skilled labour did.

Let us inspect the depiction of the Beveridge curve along the content of Figure 3: The greater the placement problems in the labour market, i.e., the higher the ratio \( \frac{\eta}{\eta_0} \), the further out the Beveridge curve is, ceteris paribus. The higher then is the unemployment rate, for any given number of job vacancies. If the unemployment rate rises from \( u_0 \) to \( u_1 \), conclusions can be drawn about the underlying cause type on the basis of the simultaneous change in the vacancy rate, \( v \).

If the system moves from point A to point B (D) with a shift from BK0 to BK1 (BK1 to BK0), i.e. if the vacancy rate increases (decreases) to the same extent as the unemployment rate and the ratio \( \theta \) (V/U) remains unchanged at 1, it is reasonable to conclude that either the placement efficiency has deteriorated (improved) or the need for placement has increased (decreased), e.g. through accelerated (delayed) structural change.

If, on the other hand, the movement takes place along BK0 to the upper left to point C, i.e., the vacancy rate decreases from \( v_0 \) to \( v_2 \), this is an indication of the existence of cyclical unemployment. Whereas unemployment in point A could be described as purely frictional-structural, in point C there is a job deficit to the extent of route CD.
Figure 3: The Beveridge curve

![Beveridge Curve Diagram]

Source: own compilation

However, the two influencing variables can overlap, as can be seen in the following Figure 4. Notice that in contrast to Bellmann/Hübler (2014), our further investigation focuses not only the cyclical aspects of the German Beveridge curve.

Let us give an example of the superposition of the influencing variables: A movement from point A to point B in Figure 4 can be explained by both a displacement (BK→BK’) and a rotation (BK→BK’’) of the Beveridge curve, since the curvature is not exactly known ex-ante. The policy implications therefore depend, among other things, on the estimation of the course of the Beveridge curve (see below). Also, the causes of displacements and/or movements along the Beveridge curve are often not independent of each other. This limits the significance of estimated Beveridge curves.

The exact measurement of vacancy rates is a task in itself, but this does not limit the significance of the Beveridge curve concept in principle. International comparisons are made more difficult, among other things, by the different methods used to collect unemployment rates and by the different reporting behaviour (e.g. due to differences in unemployment benefits).
Figure 4: Lack of selectivity in the Beveridge curve concept

Source: own compilation

3. The new “systemic” shortness of skilled labour in Germany

More and more print media (cf. Handelsblatt, FAZ) are reporting on this recent phenomenon: important German companies from a wide range of industries (automotive suppliers, household appliances, software companies, chemical giants, etc.) are massively reducing their workforce of highly qualified employees (Buchenau et al. 2024). This observation stands in sharp contrast to German firms’ behaviour in earlier recessions, characterized by explicit hoarding of skilled labour. Apparently, a significant change in management structures, in increasingly digital business models, in the vintage of the equipment and in the capital cost structures is pervading the German corporate world. In addition, weaknesses in locational competition, low growth prospects, challenges of technological change and antiquated management structures and hierarchies are to be deplored. One can speak of a veritable systemic transformation. As a result, this leads firms to reduce the number of qualified people, coupled with the desperate search for skills that the labour market often does not (yet) provide. The labour market effects of this systemic transformation in particular are by no means only anecdotal but are now leaving clear traces in the statistics. The most impressive figures in this area were collected by the KOFA: “Kompetenzzentrum Fachkräftesicherung”, a department of the “Deutsches Institut für Wirtschaftsforschung” (IW). We show a small excerpt of it in the following Table 1:
Table 1: Systemic shortness of skilled labour in Germany

<table>
<thead>
<tr>
<th>Professions</th>
<th>Job overhang rate</th>
<th>Skilled worker gap</th>
<th>Skilled worker gap</th>
<th>Unemployment overhang</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2021</td>
<td>2022</td>
<td>2022</td>
<td>07/2022-06/2023</td>
</tr>
<tr>
<td>Health, Social Affairs</td>
<td>55.1%</td>
<td>60.5%</td>
<td>156,587</td>
<td>145,315</td>
</tr>
<tr>
<td>Teaching, Education</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction, Architecture</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surveying</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building Technology</td>
<td>51.4%</td>
<td>60.0%</td>
<td>83,863</td>
<td>76,207</td>
</tr>
<tr>
<td>Natural Sciences, Geography</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Computer science</td>
<td>39.5%</td>
<td>54.2%</td>
<td>44,671</td>
<td>42,584</td>
</tr>
<tr>
<td>Raw material extraction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>production, manufacturing</td>
<td>34.8%</td>
<td>52.7%</td>
<td>163,741</td>
<td>172,62</td>
</tr>
<tr>
<td>Agriculture, forestry</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>animal husbandry</td>
<td>37.0%</td>
<td>46.7%</td>
<td>9,847</td>
<td>8,314</td>
</tr>
<tr>
<td>Business Organization</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accounting, Law</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Administration</td>
<td>24.8%</td>
<td>35.8%</td>
<td>57,657</td>
<td>59,327</td>
</tr>
<tr>
<td>Commercial Services</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Distribution,</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Trade in Goods</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Hotel, Tourism</td>
<td>11.7%</td>
<td>34.6%</td>
<td>64,663</td>
<td>55,603</td>
</tr>
<tr>
<td>Transport, Logistics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protection, Security</td>
<td>11.8%</td>
<td>32.4%</td>
<td>45,322</td>
<td>44,804</td>
</tr>
<tr>
<td>Linguistics, literature</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>humanities, social sciences</td>
<td>9.5%</td>
<td>16.3%</td>
<td>6,137</td>
<td>5,439</td>
</tr>
<tr>
<td>and economics, media art, culture,</td>
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<tr>
<td>etc.</td>
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</tr>
</tbody>
</table>

Sources: Tiedemann/Werner 2024; Specht 2024; Buchenau et al. 2024; own compilation

Explanation: Job overhang rate = skilled worker gap/open positions; skilled worker gap = vacancies that cannot be filled with suitable unemployed persons; unemployment overhang = qualified unemployed - open positions.

Three main insights can be won from Table 1: (i) the job overhang rate has increased dramatically over all professions in one year only; (ii) the skilled worker gap has decreased in all but two profession groups (the latter, however, are key for the growth of German firms); (iii) the actual unemployment overhang is actually (by absolute numbers) dominated by the skilled worker gap in all but the last two profession groups listed in the Table.

**AI as an example for the ongoing systemic transformation of the German labour market**

AI is the intelligence of machines or software, as opposed to the intelligence of living beings, primarily of humans. It is a field of study in computer science that develops and studies intelligent machines. Such machines may be called AIs. AI also provides a prominent example of a "systemic" shortage of skilled work/professionals: some companies are looking for
employees who are qualified to produce AI themselves or to participate in the production of AI. Another part of companies is searching for employees who at least have the ability to apply AI. Still other companies need employees to train previously inexperienced colleagues to use AI. And they are looking for new employees who are willing to be trained in the use of AI. If you pick up the print or digital edition of daily and business newspapers, you will find them full of corresponding search ads.

The shortage of skilled workers in the sense of an excess demand quickly sets in on the labour market: neither workers made redundant (e.g. in the recession) nor new employees entering the labour market are sufficiently available in the desired quality and quantity. This excess demand is becoming more and more pronounced in the very last years as we can observe a sort of AI boom (since 2019 for example “language programs” such as GPT) with companies, universities, and laboratories overwhelmingly based in the United States pioneering significant advances in artificial intelligence.

In the medium term, we are concerned with the question of the extent to which AI can and will replace workers. so that AI may then reduce the lack of (also qualified) work.

4. Empirical investigation of the German Beveridge curve (2006-2023)

Descriptive Statistics of the Beveridge curve

Using the most recent quarterly values of the respective years (2006-2023), the statistical Appendix 3 is clear: According to this, the Beveridge curve in the EU and in the Eurozone has been shifting to the far right again since about 2020, which (see above) indicates a decline in intermediary efficiency of the respective labour markets.

This effect correlates strongly with the increasing reporting on the shortage of skilled workers in relevant European print media (NZZ, Handelsblatt, Financial Times, etc.). We find this apparent shift confirmed for Germany as well, as shown in Figure 5 below (using quarterly figures).10

10 The relevant literature often does not yet find this current effect: “It is visible that the aggregate Beveridge Curve shifts to the left (illustrated by the fitted Beveridge Curves in green and in black). This pattern is completely in line with the actual leftward shift of the actual Beveridge Curve in Germany in the aftermath of the Hartz reforms” (Merkl and Sauerbier 2022: 21).
Figure 5: Rotation plus spatial displacement of the German Beveridge curve (2006Q4-2023Q4)

Sources: EUROSTAT; own calculations

In Figure 5, we have mapped the observed variables \((v, u)\) to the axes as suggested by the following econometric estimates, i.e., just inverse compared to Figures 3 and 4. It can be clearly seen in Figure 5, which simply plots the unconditional relationship between the quarterly vacancy and unemployment rates for Germany that the Beveridge curve – as measured by the most recent quarterly values in the respective years – is steepening in the recent past and in the present, while at the same time moving outwards. In other words: Figure 5 alone shows on the basis of merely descriptive data a sharp shift in the Beveridge curve for the 2020-2023 period.

Prior to that (around 2006-2019), however, the Beveridge curve behaves surprisingly stable and does not have loops like the European counterparts mentioned above (cf. statistical Appendix 3). In the following econometric investigations, we want to try to demonstrate the movements of the Beveridge curve mentioned above.

Estimation equations for the Beveridge curve

At least three alternative estimation equations are available for an empirical study of the Beveridge curve:

1. Estimation equation according to Mortensen/Pissarides (1994) and Pissarides (1985) in its unrestricted version \((0 < \alpha < 1)\):
\[ v = \left( \frac{s}{\eta_0} (1 - u) \right)^{1/\alpha} \frac{\alpha - 1}{u^{\alpha - 1}} \]

In log form, this would imply:

\[ \ln v = \frac{1}{\alpha} \ln \left( \frac{s}{\eta_0} \right) + \frac{1}{\alpha} \ln (1 - u) + \frac{\alpha - 1}{\alpha} \ln u \]

This makes the corresponding regression equation:

\[ \ln v = \alpha_0 + \beta_0 \ln (1 - u) - \beta_1 \ln u + \epsilon \]

for \( 0 < \alpha < 1 \).

(2) Estimation equation according to Ball et al. (2022):

\[ v = au^{b}; \quad a > 0, \quad b < 0 \]

respectively: \( \ln v = \ln(a) - b \ln u \); disadvantage: consistently estimable, since only regressors independent of \( v \) are being used, but microeconomically not founded. This makes the corresponding regression equation:

\[ \ln v = \alpha_0 - \beta_1 \ln u + \epsilon \]

(3) Current role models from literature (Duffy und Jenkins 2023): \( u = \frac{s}{s + A \sqrt{\theta}} \) with \( \theta = \frac{\nu}{\mu} = \nu \)

respectively: \( \ln u = \ln(s) - \ln(s + A \sqrt{\theta}) \); disadvantage: microeconomically founded, but not consistently estimable, since also regressors dependent of \( u \) (\( U \) is a part of \( \theta \)) are being used.

Regardless of which of the various definitions you follow, the vacancy rate is a measure of the relative number of vacancies posted on the 1st labour market. Since this process is time-consuming and costly for companies, it can be assumed that they will make use of it in particular when they are looking for replacements for existing or new skilled workers whose supposedly high productivity justifies such an effort.

**The challenge of correctly measuring vacancies and vacancy rates**

Economists have been concerned with the adequate measurement of vacancies in the labour market at least since the 1960s (e.g. Myers 1965, Joseph 1965). At this point, at the latest, it became apparent that the refilling of vacancies was not provided by the labour market as a matter of course.
There are 4 concepts for the vacancy rate $v$, which in principle can be considered for empirical studies. One of them we have implicitly presented above, it is constructed analogously to the unemployment rate, with the labour force (number of active persons) in the denominator and the number of vacancies in the numerator:

$$v_1 = \frac{V}{B}$$

Another concept is used by Duffy and Jenkins (2023: 4), among others, whereby this $v$, well-known as “vacancy-unemployment ratio” is also interpreted as "labour tightness" ($\theta$). We have already used this parameter above in the context of the matching function:

$$\theta = \frac{V}{U} = v$$

The higher (lower) the number of vacancies (unemployed), given the number of unemployed (vacancies), the greater the tension on the labour market. This indicator is also used directly by the Institut der Deutschen Wirtschaft (IW) as a measure of the shortage of skilled workers (Burstedde et al. 2020: 12). The Ifo Institute follows suite (Garnitz et al. 2023: 60). The next relation is even more convincingly constructed for our purposes, mainly because it uses the number of vacancies in the numerator and in the denominator:

$$v = \frac{V}{V + U}$$

However, both of the most recently presented concepts have in common the fact that they explicitly include the number of unemployed ($U$) in the denominator. Thus, they must be ruled out as consistent regressors for estimating the Beveridge curve if we regress on the unemployment rate.

Theoretically, only the following variant satisfies, because it defines the vacancy rate as a real percentage, which is between zero and one hundred percent or likewise between 0 and 1. It is used, among others, by EUROSTAT or for example by Sell and Reinisch (2013: 193):

$$v_3 = \frac{V}{V + NFV}$$

where $NFV = \text{number of filled vacancies}$.

Since no "labour tightness" is modelled here, the potential contribution of high vacancies to the inflation rate can be motivated differently than by tension in the labour market (Sell 2016). Thus, in principle, two (estimation equations) x two (vacancy concepts) = four different
Beveridge curves can be justified, which are accessible to a consistent econometric empirical study. Further concepts to assess the shortage of skilled work are presented in an excursus in the Appendix 2.

**Data used in the following empirical analysis**

The descriptive data used in the following empirical analysis stem without exception from two sources: the official European data pool “EUROSTAT” and the privately organized German statistical unit “Statista”.

**Estimation results for the German Beveridge curve (2006Q1-2023Q4)**

Below, we present the results drawing on quarterly values, utilizing only $v_3$ because we were unable to find enough data points for the variable $v_1$. Following Ball et al. (2022):

$$\ln v = \alpha_0 - \beta_1 \ln u + \epsilon$$

<table>
<thead>
<tr>
<th>Regression statistics</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple correlation coefficient</td>
<td>0,93021335</td>
</tr>
<tr>
<td>R square</td>
<td>0,86529688</td>
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<td>Standard error</td>
<td>0,15344742</td>
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<tr>
<td>Observations</td>
<td>72</td>
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</table>

<table>
<thead>
<tr>
<th></th>
<th>Coefficient</th>
<th>Standard error</th>
<th>t-statistic</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant***</td>
<td>-6,8851536</td>
<td>0,14659394</td>
<td>-46,96752</td>
<td>1,1539E-54</td>
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<tr>
<td>ln u***</td>
<td>-1,0245627</td>
<td>0,04831654</td>
<td>-21,205219</td>
<td>3,4399E-32</td>
</tr>
</tbody>
</table>

The simple Ball et al. model performs excellent by all relevant statistical criteria.

Following Mortensen/Pissarides (1994) and Pissarides (1985) in its unrestricted version ($0 < \alpha < 1$):

$$\ln v = \alpha_0 + \beta_0 \ln(1 - u) - \beta_1 \ln u + \epsilon$$

<table>
<thead>
<tr>
<th>Regression statistics</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple correlation coefficient</td>
<td>0,93023466</td>
</tr>
<tr>
<td>R square</td>
<td>0,86533651</td>
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<tr>
<td>Adjusted R square</td>
<td>0,86143322</td>
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<tr>
<td>Standard error</td>
<td>0,15453262</td>
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<tr>
<td>Observations</td>
<td>72</td>
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</tbody>
</table>
The more sophisticated model in the vein of Mortensen/Pissarides (1994) and Pissarides (1985) performs a bit less good. In particular, the estimated coefficient of $\ln (1-u)$ is not significant.

We continue with a dummy augmented model of the approach given by Ball et al. (2022). We introduce dummies to possibly capture the time-dependent shift of the Beveridge curve:

$$\ln v_t = \alpha_0 + \alpha_1 D_1 + \alpha_2 D_2 + \alpha_3 D_3 + \alpha_4 D_4 - b_1 \ln u_t + \epsilon_t,$$

where:

- $D_1 = 0$ for QI2006 – QIV2019 and QI 2021 - QIV 2023 as well as $D_1 = 1$ for QI2020 – QIV2020.
- $D_3 = 0$ for QI2006 – QIV2021 and QI 2023 - QIV 2023 as well as $D_3 = 1$ for QI2022 – QIV2022.
- $D_4 = 0$ for QI2006 – QIV2022 and $D_4 = 1$ for QI2023 – QIV2023.

All dummies but $D_2$ contribute to the satisfying results which point at positive (outward) shifts of the Beveridge curve in the years 2022 and 2023.

We continue with a dummy augmented model of the approach given by Mortensen/Pissarides (1994) and Pissarides (1985) in its unrestricted version ($0 < \alpha < 1$). We again introduce dummies to possibly capture the time-dependent shift of the Beveridge curve:
\[ \ln v_t = a_0 + a_1 D_1 + a_2 D_2 + a_3 D_3 + a_4 D_4 + a_5 D_5 + b_0 \ln(1 - u_t) - b_1 \ln u_t + \varepsilon_t, \]

where:

\( D_1 = 0 \) for QI2006 – QIV2019 and QI 2021 - QIV 2023 as well as \( D_1 = 1 \) for QI2020 – QIV2020.

\( D_2 = 0 \) for QI2006 – QIV2020 and QI 2022 - QIV 2023 as well as \( D_2 = 1 \) for QI2021 – QIV2021.

\( D_3 = 0 \) for QI2006 – QIV2021 and QI 2023 - QIV 2023 as well as \( D_3 = 1 \) for QI2022 – QIV2022.

\( D_4 = 0 \) for QI2006 – QIV2022 and \( D_4 = 1 \) for QI2023 – QIV2023.

<table>
<thead>
<tr>
<th>Regression statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple correlation coefficient</td>
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<tr>
<td>R square</td>
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<td>Adjusted R square</td>
</tr>
<tr>
<td>Standard error</td>
</tr>
<tr>
<td>Observations</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Coefficients</th>
<th>Standard error</th>
<th>t-statistic</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant ***</td>
<td>-4.8575504</td>
<td>1.06893072</td>
<td>-4.544308</td>
</tr>
<tr>
<td>D1*</td>
<td>-0.1267525</td>
<td>0.07445019</td>
<td>-1.7025136</td>
</tr>
<tr>
<td>D2</td>
<td>0.10267427</td>
<td>0.07515071</td>
<td>1.36624483</td>
</tr>
<tr>
<td>D3***</td>
<td>0.29524011</td>
<td>0.08152276</td>
<td>3.62156657</td>
</tr>
<tr>
<td>D4**</td>
<td>0.19480621</td>
<td>0.08474874</td>
<td>2.29863242</td>
</tr>
<tr>
<td>ln(1-u)*</td>
<td>7.6780471</td>
<td>4.39313386</td>
<td>1.74773803</td>
</tr>
<tr>
<td>Inu*</td>
<td>-0.4819329</td>
<td>0.27802821</td>
<td>-1.7333957</td>
</tr>
</tbody>
</table>

Now, also the coefficient of \( \ln (1 - u) \) is significant. All dummies but \( D_2 \) contribute to the satisfying results which point at positive outward shifts of the Beveridge curve in 2022 and 2023.

5. Suggestions for economic policy

The empirical estimation of different Beveridge curves for Germany (2006-2022) has shown that the relationship between the vacancy rate and the unemployment rate is rather stable. However, the analysis of quarterly data also shows that since around 2020 there has been some outward "movement" in the German Beveridge curve, which is very likely related to a systemic worsening shortage of skilled workers. The current outward displacement of the Beveridge curve signals a lower intermediation efficiency/a higher intermediation demand.

In times of a significant systemic shortage of skilled workers (the number of vacancies for certain qualifications is a multiple of the visible potential labour supply), there is actually a need for a particularly efficient labour market, whose placement services help to prevent the former
from getting out of hand. Today's evaluation of the almost 20-year-old Hartz reforms has already shown:

“The economic policy lesson (for future reforms and other countries) of our paper is that the organizational restructuring of the Federal Employment Agency was successful because it devoted more resources to initiate more effective private job search. By contrast, improved public job intermediation was unimportant for the decline of German unemployment” (Merkl and Sauerbier 2022: 4).

There is little reason to believe that the German federal agency (“Bundesagentur für Arbeit”) can play a better role now, in times of a systemic skilled workers shortage. The "effective private job search" should basically come (in contrast to the Hartz reforms) from the company side. Therefore, this is where German policymakers should start in order to support companies effectively and efficiently in their search for skilled workers. In detail, the following types of measures can be imagined:

*Exploiting the potential of domestic skilled workers*

The chief economist of the Handelsblatt, Bert Rürup, advises better working conditions and higher wages, but above all to make it easier for women to work full-time: "Almost every second employed woman today works part-time – although women's participation in education is now higher than that of men." (Handelsblatt Morning Briefing of 17.02.2023).

*Conditional Immigration Policy with the "Opportunity Card"

The aim is to attract more qualified immigrants to Germany: the German government hopes that the reform of the law on the immigration of skilled workers will result in 75,000 additional workers per year. The aim is to facilitate the immigration of skilled workers from outside the EU. Germany is increasingly dependent on this, as labour migration from other EU countries is declining. At the same time, education and training measures are intended to make better use of Germany's potential.

The “opportunity card” is a system for finding a job that is based on a points system, following the model of immigration countries such as Canada. It considers criteria such as German or English skills, professional experience, connection to Germany, age and potential of the accompanying spouse or partner. Those who achieve the necessary points will receive a residence permit of up to one year to look for work in Germany, even without a concrete job offer (NZZ briefing of 30.03.2023). A recent representative survey in Portugal has shown that
70% of nationals there require immigrants to present an employment contract, following the example of countries such as Australia and Canada (Albuquerque and Moleiro 2023).

Top German representatives of employers and employees have welcomed the opportunity card plans with rare unanimity and called for further reforms in the responsible administration. This is one of the first stations with which immigrants come into contact. However, long waiting times, non-transparent procedures and time-consuming bureaucracy in a foreign language would have a deterrent effect.

More than 25 years ago (Sinn 1997) there was an intensive discussion in Europe about how states could attract mobile factors of production in "global locational competition". At that time, it was mainly physical capital that was meant. Today, in the age of a shortage of skilled workers, the focus is increasingly on the factor of "skilled work" or human capital (O'Connor 2023: 17): „countries are increasingly competing with one another to draw skilled workers to their shores“ (ibid.).

Today, as in the past, there may be a significant error in thinking: in the concept of the social market economy, states do not have the task of actively participating in competition themselves, but rather of (only) organizing it, controlling it, and even limiting it in the end – in the event of undesirable outcomes. You can't be a player and a referee at the same time (Sinn 1997). It is (only) the responsibility of the state to create the framework with a transparent immigration law within which companies, universities, NGOs, etc. can strive for qualified immigration and at the same time set attractive incentives to curb an undesirable emigration of qualified and highly qualified people.

The U.S. has had mostly positive experiences with controlled immigration: as Krugman (2023: 12) reports, the dependency ratio, i.e. the ratio between those who are not yet and no longer in employment to the age groups between 18 and 64 years, is 27.5%. For residents who were not born in the USA, this dependency ratio is only 5.8%.

*Education, training, and reskilling of workers to achieve higher skills*

Obviously, there are major deficiencies in the German education "system", which affect not only the trainees (motivation, willingness to integrate, etc.), but also the trainers (lack of preparation, unnecessary hierarchical levels, etc.): The number of successful school leavers is falling, every 4th trainee drops out of the vocational training. Of those who dropped out, 60% say it was not their dream job (Keilen 2023: 14). The number of training contracts in Germany has been decreasing or stagnating since the beginning of the millennium (ibid.). The number of
20–34-year-olds without vocational training exceeds the 2.5 million mark and has been increasing continuously since 2016.

*Flexibilization of pensions, which allows people to work longer after reaching retirement age, low employment in addition to drawing a pension*

"A general extension of working life seems to be possible only to a limited extent: a look at France should make us sceptical here" (Linowski 2023: 7). Precisely because this is the case, the flexibilization of pensions (employees decide for themselves whether they want to retire early with reductions or whether they want to continue working beyond the statutory retirement age, with the prospect of higher pension payments) as well as low employment in addition to drawing a pension should be designed to be incentive-compatible: working longer periods of time should be able to help increase not the quantity but the quality of leisure use.

Accordingly, there is no "one" effective and efficient instrument, but rather an intelligently coordinated use of a wide variety of economic policy means to reduce the shortage of skilled workers. Last but not least, intelligent means that it is precisely in their interaction that the instruments are suitable for increasing the productivity of skilled labour. AI in particular will play an important role in this.

On an annual average of 07/2022-06/2023, a qualified unemployment overhang of around 280,000 is offset by a skilled worker gap of just over 340,000 people across all occupational groups (Tiedemann/Werner 2024: 1-2). This is the new picture of the German labour market, which is suffering from a systemic shortage of skilled workers. Therefore, a short-term change of occupation of unemployed persons who can't find a suitable vacancy, is only an option for a few. The majority would have to acquire missing skills and qualifications in the context of further education and training (ibid.: 3).

6. **Summary of findings and conclusions**

First, in this article, we have used traditional descriptive measures (v, u, etc.) to show the current imbalances in the German labour market (especially since 2020). Following Mortensen/Pissarides 1994 and Pissarides 1985, we then developed the matching function on the labour market and the Beveridge curve based on it step by step, interpreted it graphically and derived all its analytical properties.

It was important for us to show how systemic shortages of skilled workers influence the crucial positional parameters of the Beveridge curve, s and \( \eta_0 \), in such a way that it tends to "deteriorate" its position, i.e. it migrates outwards.
Systemic shortness of skilled labour makes firms act differently than in earlier recessions: they tend to even reduce the number of qualified employed people, coupled with the desperate search for skills (related to AI, for example) that the labour market often does not (yet) provide. The KOFA: "Competence Centre for Securing Skilled Workers", a department of the "German Institute for Economic Research" (IW), has developed suitable new descriptive measures (job overhang rate, skilled worker gap, unemployment overhang) for this situation which we reported for the last few years.

We were able to show on the basis of merely descriptive data a sharp shift in the Beveridge curve for the 2020-2023 period. Before we proceeded to the estimation work, we thoroughly discussed the 4 concepts for the vacancy rate v, which in principle can be considered for empirical studies. In the subsequent econometric investigations, we could demonstrate the movements of the Beveridge curve mentioned by introducing time dependent dummies into an ordinary least squares regression (2006-2023).

The current outward displacement of the Beveridge curve signals a lower intermediation efficiency/a higher intermediation demand on the German labour market. Therefore, German policymakers should support companies effectively and efficiently in their search for skilled workers. We have proposed, in line with many other German economists, a number of measures which should be taken as complementary.

7. Literature


Buchenau, M. et al. (16.02.2024), Und raus bist Du! Handelsblatt 34: 46-51.


Garnitz, J. et al. (2023), Arbeitskräftemangel belastet die deutsche Wirtschaft. Ifo Schnelldienst 9: 60-64.


Huchzermeier, D. et al. (08.03.2024), Der Wirtschaft steht ein weiteres Jahr mit roten Zahlen bevor. Handelsblatt 49: 12-13.


Keilen, A. (15.06.23), Niemand sollte nur der Depp vom Dienst sein. Handelsblatt 113: 14-15.


Linowski, D. (2023), Erkennen, was ist – sagen, was ist. Wirtschaft & Ethik 33 (1): 3-9.


**Mathematical Appendix 1: A formal derivation of the Beveridge curve**

The change in employment ($B$) in any period $t$ is $\Delta B = \eta U - sB$ with $s =$ proportion of employees who lose their jobs; $\eta =$ proportion of unemployed people finding a job (see for the following Mortensen/Pissarides 1994 and Pissarides 1985):

Letting $\alpha$ ($0 < \alpha < 1$) be the vacancy share of hires in the matching function:

$$\Delta B = \eta U - sB = \eta_0 \frac{V^\alpha U^{-\alpha}}{\theta^\alpha} \cdot U - sB = \eta_0 V^\alpha U^{1-\alpha}$$

For **equilibrium employment** ($\Delta B = 0$), the “steady state” of unemployment and/or of vacancies can be determined:

$$\Delta B = 0 \rightarrow sB = \eta_0 \frac{V^\alpha U^{-\alpha}}{\theta^\alpha} \cdot U = \eta_0 V^\alpha U^{1-\alpha}$$

In a few steps we get:

$$\frac{S}{\eta_0} B = V^\alpha U^{1-\alpha}$$

$$\frac{S}{\eta_0} BU^{\alpha-1} = V^\alpha$$

And, we achieve:

$$\frac{S}{\eta_0} \frac{B}{U^{1-\alpha} B^\alpha} = \frac{V^\alpha}{B^\alpha} = v^\alpha$$

With

$$u = \frac{U}{B}$$

where $\bar{B}$ stands for the labour force and

$$\frac{\bar{B}}{B} = (1 - u).$$

Hence:

$$\frac{S}{\eta_0} \frac{B}{U^{1-\alpha} B^\alpha} = \left[ \frac{S}{\eta_0} \frac{B}{\bar{B}} \right] \left( \frac{U}{\bar{B}} \right)^{\alpha-1} = \left[ \frac{S}{\eta_0} (1 - u) \right] \left( \frac{U}{\bar{B}} \right)^{\alpha-1}$$

This results in the “unrestricted” Beveridge curve:
\[
\nu = \left( \frac{s}{\eta_0} (1 - u) \right)^{1/\alpha} \frac{u^{\alpha - 1}}{u^{\alpha}}
\]

where \( \nu \) is the vacancy rate (vacancies as a percent of the labour force or vacancies + employment), and \( u \) is the unemployment rate (unemployment as a percent of the labour force), with the features:

\[
\frac{\delta \nu}{\delta u} = \left( \frac{s}{\eta_0} \right)^2 \left( \frac{-1}{u^{1/\alpha}} + 1 \right) < 0 \text{ for } 0 < u < 1
\]

\[
\frac{\delta^2 \nu}{\delta u^2} = \left( \frac{s}{\eta_0} \right)^2 \left( \frac{1/\alpha}{u^{1+1/\alpha}} \right) > 0 \text{ for } 0 < u < 1
\]

The Beveridge curve therefore has a negative slope, with a decreasing curvature. We observe the following effects as a consequence of parameter variations:

\[
\frac{\delta \nu}{\delta s} = \frac{1}{\alpha} \frac{s^{\alpha-1}}{\eta_0^{1/\alpha}} (1 - u)^{1/\alpha} \frac{u^{\alpha - 1}}{u^{\alpha}} > 0 \text{ for } 0 < u < 1
\]

\[
\frac{\delta \nu}{\delta \eta_0} = -\frac{1}{\alpha} \frac{s^{\alpha}}{\eta_0^{(1+\alpha)/\alpha}} (1 - u)^{1/\alpha} u^{\alpha-1} < 0 \text{ for } 0 < u < 1
\]

An increased (decreased) probability of dismissal (labour market re-entry) therefore shifts the Beveridge curve outwards.

In log form, the unrestricted Beveridge curve would imply:

\[
\ln \nu = \frac{1}{\alpha} \ln \left( \frac{s}{\eta_0} \right) + \frac{1}{\alpha} \ln (1 - u) + \frac{\alpha - 1}{\alpha} \ln u
\]

This makes the corresponding regression equation:

\[
\ln \nu = \alpha_0 + \beta_0 \ln(1 - u) - \beta_1 \ln u + \epsilon
\]

where the slope of the Beveridge curve is \( \beta_1 \) and shifts are captured by the intercept, \( \alpha_0 \).
Appendix 2: Excursus on vacancy days and the skilled workers index

In order to be absolutely sure that the shortage of skilled workers can actually be identified beyond the shortage of workers, the vacancy period (Müller 2020) can in principle be considered in addition to the (relative) number of vacancies. The following definitions apply:

Vacancies = Number of advertised positions within one year (positions) = V

Vacancy time = number of days on which an advertised position had remained open within one year prior to it was filled (days) = FT.11

From this, the following indicators can be developed, for which there is currently no representative information in Germany:

Vacant job days = V x FT (dimension: days) or:

Vacant job day quota = FT x vi ; i = 1 to 4 (dimension: days x decimal)

Another option is to directly use a "skilled worker index", such as the one reported by Statista (2023a). This shows (Q12015 = 0) a consistent increase in the index from Q22020 to the first quarter of 2022. After a transitory cyclical decline in quarters 2, 3 and 4 of 2022, the index is now rising again, and it is currently over 100% higher than in the base quarter of 2015.

11 Cf. a small descriptive empirical example from Germany is given below in the statistical Appendix 4. Although the IW (Burstedde et al. 2020: 12 ff.) points out a number of methodological weaknesses of the FT-es, this fact however, we believe, does not make the combination with other measures such as V or vi meaningless.
Statistical Appendix 3: European Beveridge curves (2006Q4 - 2022Q4)

Beveridge curve, 2006Q4 to 2022Q4 (four-quarter average rates)

Source: Eurostat (online data codes: yrs_q_nace2, lfsq_urgan)
Statistical Appendix 4: Measuring shortness of skilled labour by the number of vacant days

A corresponding position must remain vacant for a longer period of time in order to speak of a shortage of skilled workers. The vacancy period refers to the period of time it takes for an advertised position to be filled by the skilled worker sought. Based on the vacancy period, you can see how the shortage of skilled workers is currently (2022) in Germany: For more than a decade, companies have had to search longer and longer until they finally find the right employees. This shows that the vacancy period in some occupations is significantly longer than in others. Such occupations, in which the shortage of skilled workers is particularly noticeable, are called bottleneck occupations. The following overview shows the bottleneck occupations in Germany in 2022 with the associated vacancy periods.

<table>
<thead>
<tr>
<th>Bottleneck occupations</th>
<th>Vacancy period (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medicine</td>
<td>157</td>
</tr>
<tr>
<td>Construction and architecture</td>
<td>130</td>
</tr>
<tr>
<td>Technical engineering</td>
<td>115</td>
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<tr>
<td>Economics</td>
<td>107</td>
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<td>Media, advertising, marketing</td>
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<tr>
<td>Law</td>
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<td>Psychology</td>
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<tr>
<td>Humanities, social sciences and journalism</td>
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<tr>
<td>Teaching staff</td>
<td>62</td>
</tr>
<tr>
<td>Administration and library</td>
<td>47</td>
</tr>
</tbody>
</table>

Source: Bundesagentur für Arbeit (2023)