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Phillips meets Beveridge in Germany, the euro area, the United Kingdom, and the US

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Abstract

The Phillips and Beveridge curves have long served as useful tools for macroeconomic analysis and decision-making, linking inflation to labour market slack and unemployment to job vacancies, respectively. Recently, some authors have turned their attention to the vacancy-to-unemployment (VU) ratio as a potentially more informative measure of slack, particularly when the Beveridge curve shifts (e.g., Barnichon and Shapiro (2024)). Inspired by these recent studies, we conduct an analysis of the empirical behaviour of the Phillips and Beveridge curves in Germany, the euro area, the United Kingdom, and the United States between the early 2000s and 2024. Our aim is to assess the relevance and stability of those curves and, furthermore, to investigate whether a Phillips curve specification with the VU ratio as driving variable – a *Phillips-meets-Beveridge* Phillips curve – better models inflation dynamics than a standard unemployment rate-driven Phillips curve. We use quarterly time series of inflation, inflation expectations, unemployment, vacancies, and energy prices to estimate linear Beveridge curves and Phillips curves that draw from both the New Keynesian tradition and Gordon's Triangle Model of inflation. We identify structural breaks in the relationships via Bai-Perron tests and proceed to conduct subsample estimations to assess changes in slopes over time. Results confirm a persistent negative vacancy-unemployment relationship, with the United States displaying greater responsiveness than European economies. Traditional Phillips curves are relatively flat throughout the period. Overall, the *Phillips-meets-Beveridge* Phillips curve typically provides a better fit than its unemployment rate-based counterpart.

JEL Codes: C29, E31, E32, J20

Keywords: Phillips curve; Beveridge curve; Structural stability; Germany; euro area; United Kingdom; United States

Resumo

Há muito que as curvas de Phillips e de Beveridge servem como instrumentos úteis para a tomada de decisões macroeconómicas, relacionando a inflação com o "slack" do mercado de trabalho e o desemprego com as vagas de emprego, respectivamente. Recentemente, alguns autores têm centrado a sua atenção no rácio entre vagas de emprego e desemprego (VU) como uma medida potencialmente mais informativa do "slack", especialmente perante deslocações da curva de Beveridge (por exemplo, Barnichon e Shapiro (2024)). Inspirados por alguns destes estudos recentes, realizámos uma análise do comportamento empírico das curvas de Phillips e de Beveridge na Alemanha, na Área do Euro, no Reino Unido e nos Estados Unidos, entre o início da década de 2000 e 2024. O nosso objectivo é avaliar a relevância e estabilidade dessas curvas e, além disso, investigar se uma especificação da curva de Phillips com VU como variável explicativa – uma curva *Phillips-meets-Beveridge* – modela melhor as dinâmicas inflacionárias do que uma curva de Phillips "standard", que utiliza a taxa de desemprego como variável explicativa. Criámos conjuntos de dados trimestrais sobre a inflação, expectativas de inflação, desemprego, vagas e preços da energia, que são utilizados para estimar curvas de Beveridge lineares e curvas de Phillips que combinam elementos da tradição Nova Keynesiana e do Modelo Triangular. Identificámos quebras estruturais nas relações através de testes de Bai-Perron e procedemos a estimativas por subamostras para avaliar alterações na inclinação das curvas ao longo do tempo. Os resultados confirmam uma relação negativa persistente entre vagas e desemprego, sendo que os Estados Unidos revelam maior sensibilidade do que as economias europeias. As curvas de Phillips tradicionais mantêm-se relativamente planas ao longo do período. Em geral, a curva de Phillips baseada no rácio VU apresenta um melhor ajustamento do que a sua congénere baseada na taxa de desemprego em todas as regiões.

Códigos JEL: C29, E31, E32, J20

Palavras-chave: Curva de Phillips; Curva de Beveridge; estabilidade estrutural; Alemanha; Área do Euro; Reino Unido; Estados Unidos

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1. Introduction

Over the past decades, the joint dynamics of inflation and unemployment, traditionally analysed with the Phillips curve, has been subject to considerable scrutiny, particularly in the wake of a series of profound economic disruptions. The Global Financial Crisis (GFC), for instance, led to a sharp and prolonged increase in unemployment across advanced economies, without the disinflation predicted by the Phillips curve, prompting many authors to revisit the theoretical foundations and empirical validity of the Phillips curve (e.g., Ball and Mazumder (2011); Coibion and Gorodnichenko (2015)). Similarly, the euro area Sovereign Debt Crisis (SDC) laid bare the heterogeneity of labour market responses within a monetary union. More recently, the COVID-19 pandemic brought about unprecedented economic distortions that produced highly irregular patterns of both labour market and price dynamics.

These crises have led researchers to reconsider the stability and slope of the Phillips curve. Moreover, some authors turned their attention towards another well-known, although less used, relationship: the Beveridge curve, linking unemployment and job vacancies.

The history, impact, and place in economic thought of the Phillips curve, with all its varieties following the specific formulation in Phillips' (1958) seminal work, are thoroughly documented (see, e.g., Gordon (2011); Leeson (2000); Qin (2011)). The Beveridge curve, however, has so far played a secondary role in macroeconomic analyses and models (Blanchard & Diamond, 1989; Rodenburg, 2011). Recently there has been a renewed interest in the unemployment-vacancy relationship as a tool for macroeconomic analysis and even decision-making, particularly during the pandemic period (e.g., Benigno and Eggertsson (2024); Bok et al. (2022); Figura and Waller (2022)). Such interest stems from its ability to better reflect the labour market dynamics, by considering both its supply and demand sides, and therefore to better explain inflation dynamics.

Although independent analyses of these relationships are undoubtedly informative, we argue it is more productive to see them as complementary. One of the most debated issues surrounding the Phillips curve is the appropriate measure of economic slack (Barnichon & Shapiro, 2024). Should slack be proxied by the unemployment rate, as originally suggested by Phillips (1958)? Or should we follow the developments of Phelps (1967, 1968) and Friedman (1968), and opt instead for the unemployment gap? Are marginal costs or the labour share (or even the output gap) as suggested by Galí and Gertler (1999), preferable? There is indeed a wide range of potential measures of slack. The recent work of Barnichon

and Shapiro (2024) indicates that the vacancy-to-unemployment (VU) ratio outperforms traditional indicators. This appears to be due to shifts in the Beveridge curve leading to shifts in the Phillips curve.

Inspired by Barnichon and Shapiro (2024), in this dissertation we assess the empirical evolution of the Phillips and Beveridge curves, both separately and exploring their possible relationship. We study four regions from the early 2000s to 2024: Germany, the euro area (EA), the United Kingdom (UK), and the United States of America (US). There are no similar analyses in the literature for the three European regions that we study, and while the US case has been addressed by Barnichon and Shapiro (2024), we keep it as a benchmark given that our econometric framework is different from that of Barnichon and Shapiro (2024).

Our aim is to assess the stability of the Beveridge curve and the Phillips curve, focusing on their slopes, and then combining both curves to document whether the VU ratio is more helpful than the unemployment rate to explain inflation dynamics – *i.e.* whether a *Phillips-meets-Beveridge* Phillips curve is superior to the standard Phillips curve in explaining inflation. To address these questions, we adopt an empirical approach grounded in standard linear regressions, consisting of the following. First, we estimate full-sample linear specifications of the Beveridge curve and of two specifications of the Phillips curve, one with the unemployment rate as driving variable, and another with the VU ratio. Then, we assess the stability of their slopes with Bai and Perron (1998, 2003) structural break tests. Finally, we estimate all curves for the subsamples indicated by the break tests, and compare their shape over time.

With this dissertation we hope to contribute to the literature by providing consistent evidence of the (un)stability of the Phillips and Beveridge curves, as well as of a Phillips curve that exploits the Beveridge relationship – thus evaluating the empirical validity of using the VU ratio as an alternative slack measure in inflation modelling. In the spirit of Barnichon and Shapiro (2024), in this dissertation *Phillips meets Beveridge* not only in the US but also in three European regions where they had never met before.

The structure of the dissertation is as follows: Section 2 presents a review of the literature on the Phillips and Beveridge curves, as well as on the use of the VU ratio in recent empirical work; Section 3 describes our econometric methods and the data. In Section 4, we present and discuss our results. Finally, Section 5 concludes by summarising the findings, discussing their relevance, and suggesting avenues for future research.

2. Literature review

In this chapter, we review the literature on the Phillips and Beveridge curves. Section 2.1 delves into the origins of the Phillips curve, its many developments, and current empirical evidence on its changes throughout time. Section 2.2 presents a similar analysis of the Beveridge curve. Finally, section 2.3 explores the literature relating both curves.

2.1. The Phillips curve

The Phillips curve was first suggested by Phillips' (1958) quantitative analysis of data collected for the 1861-1957 period in the United Kingdom. Phillips (1958) estimates an equation of the form

$$\log(y + a) = \log b + c \log x \tag{2.1}$$

He denoted the rate of change of money wage rates by y, and the percentage unemployment rate by x. Parameters b and c were estimated with least squares, based on data points within the unemployment range of 0 to 5 per cent. The third parameter, a, was selected by trial and error, so as to ensure the curve provided a reasonable fit to the remaining data points, which fell within the 5 to 11 per cent unemployment range. From this study, Phillips established that there existed an inverse relationship between unemployment and the rate of change of nominal wages.

However, Phillips was not the man responsible for the popularisation of his work. That honour would belong to Samuelson and Solow (1960), who popularised Phillips' analysis, while also coining the term "Phillips curve" (Gordon, 2011). Samuelson and Solow (1960) conducted a similar analysis for the United States of America, something which had not yet been done up to that point. Importantly, in their adaptation they reformulated Phillips' wage-based curve into an inflation-based version, thereby linking unemployment directly to price inflation rather than wage changes. This provided valuable contributions to the understanding of the Phillips curve. Notably, Samuelson and Solow (1960) acknowledged that the curve is not static, with the unemployment-inflation relationship possibly shifting as a result of structural changes. They used the example of a low-pressure economy, in which the Phillips curve could shift either upwards or downwards, depending on the observed change: expectations of low inflation could lead to a downward shift, while aggravated structural unemployment could lead to an upward shift (Samuelson & Solow, 1960). Unfortunately, they do not account for the long run implications of a high-pressure economy in the long run, in particular, the increases of inflation expectations by consumers and their

associated effects in the Phillips curve, leading it to shift upward (Gordon, 2011).

Following Samuelson and Solow (1960) and the popularisation of the Phillips curve, a period of excitement came about where policy-makers believed it to be possible to exploit the inflation-unemployment trade-off as a way to reduce unemployment at the cost of a little more inflation (Gordon, 2011). However, it was also during this period that the first doubters of the Phillips curve emerged. Among these were Phelps (1967, 1968) and Friedman (1968). Both authors came to a similar conclusion at roughly the same time: the Phillips curve cannot hold in the long run.

According to Phelps (1967, 1968), in the long run the economy's Phillips curve will be vertical at the equilibrium rate of employment. Friedman (1968) came to an equivalent conclusion in his AEA presidential address. In it, Friedman stated that in the long run, policy-makers are stuck with the natural rate of unemployment – that is, "the level that would be ground out by the Walrasian system of general equilibrium equations" (Friedman, 1968, p. 8). This focus on the long run was a major theme of Friedman's address. While Samuelson and Solow (1960) regarded the long run simply as the result of a succession of Keynesian short runs, Friedman (1968) considered it as the period during which the principles of classical economics, particularly monetary neutrality, apply. His view cemented the idea that over time, unemployment eventually converges to its natural rate, no matter what the central bank does (Mankiw & Reis, 2018), which again reinforces the inability of the Phillips trade-off to hold in the long run.

Phelps (1967, 1968) and Friedman's (1968) contributions result from the incorporation of inflation expectations into the theory of the Phillips curve, with the ultimate role of providing some micro foundations to the theory. Phelps (1967, 1968) ascertained that the negative relation between inflation and unemployment lasts only as long as inflation expectations are unchanged. As these expectations adjust to match actual inflation, the trade-off vanishes, with the Phillips curve becoming vertical at the natural rate of unemployment. Likewise, Friedman (1968) sees expectations as central to explaining why the economy might seem to exhibit a Phillips curve trade-off and how that trade-off would vanish if attempts were made to exploit it. For Friedman (1968), the inflation-unemployment trade-off was always temporary, and stemmed, much like in Phelps (1967), from unanticipated inflation.

This focus on expectations sparked the rational expectations revolution (Mankiw & Reis, 2018), the next major advancement of the Phillips curve. The shift from adaptive to rational expectations has even been considered "one of the defining features in the rebuilding of

macroeconomics" (Coibion & Gorodnichenko, 2012, pp. 116-117). Spearheaded by Muth (1961) – who believed that "economic models do not assume enough rationality" (Muth, 1961, p. 316) – and popularised by Lucas (1972, 1973, 1975), rational expectations suggest that economic agents, knowing the true model of how the economy works, use all available relevant information efficiently, forming predictions that are, on average, correct. Building on the work of Phelps and Friedman, Lucas (1972, 1973, 1975) introduced rational expectations to the analysis of the Phillips curve. In the Lucas Islands Model, the economy is composed of many informationally isolated "islands" (firms or local markets), each observing only the price of its own output but not the overall price level. When a firm sees its price rise, it cannot immediately tell whether this reflects a relative price change or a general increase in prices across the economy. If the firm interprets the shock as a relative one, it increases output. However, if the shock is purely nominal, this leads to a misallocation of resources. This temporary confusion allows unanticipated monetary shocks to affect real output in the short run. Over time, as agents form rational expectations and learn the structure of the economy, monetary policy becomes neutral in its effects on real variables. This way, Lucas was able to explain why the Phillips trade-off is smaller in economies with higher macro volatility (Gordon, 2011).

Truly, the 1960s and early 1970s were the golden age of the Phillips curve. In these years, the Phillips curve was widely studied, with many authors consistently contributing to improving its formulation. However, the 1970s proved to be a turning point for the Phillips curve. During this period, the inflation-unemployment relationship was highly questioned, as empirical data suggested it to be positive rather than negative, which contradicted Phillips' (1958) original results. This was especially evident during the period of stagflation, when both inflation and unemployment rose simultaneously.

These empirical anomalies prompted a rethinking of the theoretical foundations of the Phillips curve. Gordon (2011, p. 20) states that "1975 marks a clear break in the history of the PC", and after that point, the theory surrounding the Phillips curve came to a fork in the road. Doctrine has diverged into two different paths. One path revived Keynesian economics by incorporating long run neutrality, the role of supply shocks, and the effect of past inflation as a measure of inertia. The other path opted to focus on forward-looking, rational expectations, which responded to effective and future expected changes in both monetary and fiscal policy, with the interplay between expectations and policy formation leaving no room for supply shocks or inertia (Gordon, 2011).

From the first path came the Triangle Model (Gordon, 1977a, 1977b, 1981, 1982), developed in the late 1970s and early 1980s as an attempt to bridge the gap between theoretical predictions and the empirical reality. The model argues that inflation stems from three distinct sources, each representing a side of the triangle: demand-driven pressures, supply shocks (such as oil price shocks), and inflation inertia. Demand-pull inflation stems from excess demand in the economy and is captured in the model by the deviation of unemployment from its natural rate. Supply shocks, such as sudden increases in oil prices or changes in import prices, reflect cost-push inflation, which raises production costs independently of domestic demand conditions. Finally, inflation inertia captures the idea that past inflation influences current inflation due to factors such as wage and price contracts. The model can be represented by the following equation (adapted from Gordon (1977b), equation 13):

$$\pi_t = E(\pi_t) + \beta(U_t - U_t^N) + z_t + \epsilon_t \tag{2.2}$$

Here, π_t is the inflation rate, $E(\pi_t)$ is the expected rate of inflation, U_t is the unemployment rate, U_t^N is the natural rate of unemployment, z_t represents supply shocks, and ϵ_t is an error term.

From the alternative path emerged one of the most significant advancements of economic thought and research of the last century: the New Keynesian Phillips Curve (NKPC), a model that has arguably dominated much of the economic discourse since the 2000s (Gordon, 2011). The NKPC model focuses on providing the Phillips curve with micro foundations. To do so, it considers monopolistically competitive firms, which (due to product differentiation) have pricing power, but face frictions when adjusting prices. These frictions have many possible explanations within theoretical New Keynesian literature, but are often perceived to follow Calvo's (1983) model of staggered prices, in which nominal prices are assumed not to be subject to continuous revisions, instead being changed only occasionally, in a non-synchronous manner, by taking into account firms' expectations on future prices and the "state of the market" (Calvo, 1983, p. 1). The NKPC further states that inflation (π) depends on two main variables: inflation expectations, denoted by $E_t\{\pi_{t+1}\}$, and the output gap, represented by $\tilde{y}$ (Galí, 2018).[1]

[1] Actually, the price theory of a monopolistic competition setup leads to the real marginal costs being the main driving variable of inflation (Galí & Gertler, 1999; Galí et al., 2001). The literature firstly proxied real marginal costs with unit labour costs, but the empirical unsuccess of such specification lead most authors to return to an output or unemployment gap formulation of the Phillips curve (Gordon, 2011, 2013).

$$\pi_t = \beta E_t\{\pi_{t+1}\} + k\tilde{y}_t \quad (2.3)$$

This formulation does not stray too far from Phillips (1958), except in respect to the addition of inflation expectations. The output gap serves as a measure of the economy's operation relative to full-employment and potential output, performing a similar role to the unemployment rate in Phillips' (1958) original formulation of the Phillips curve, leading the NKPC to still demonstrate a possible trade-off between unemployment and inflation (Binder & Kamdar, 2022).

While the Triangle Model and the NKPC may appear to represent two competing strands of thought, contemporary macroeconomic research often appears to treat them as complementary rather than mutually exclusive. In practice, empirical models of inflation often blend forward-looking expectations from the NKPC with the backward-looking inertia emphasised in the Triangle Model, and most include supply-shock elements from the Triangle Model (see, e.g., Coibion and Gorodnichenko (2015); Furlanetto and Lepetit (2024); Hobijn et al. (2023)).

But what of the empirical Phillips curve? Does reality hold up to the predictions of theory?

Recently, studies appear to point out that the Phillips curve has been flattening (Ball & Mazumder, 2011; Blanchard, 2016; Coibion & Gorodnichenko, 2015; Del Negro et al., 2020; Galí & Gambetti, 2019). Coibion and Gorodnichenko (2015) find evidence of flattening since the mid-1980s, concluding that this phenomenon could explain some of the missing deflation felt during the Great Recession (GR). Blanchard (2016), for one, argues that the Phillips curve steepened between the 1960s and 1970s, but then started flattening until the late 1980s, remaining somewhat stable since. Ball and Mazumder (2011) reach a similar conclusion, estimating that the slope of the Phillips curve heavily declined in the 1960-1970 period. Following this, it remained stable until the 1980s, at which point it observed a sharp rise. The slope re-stabilised in 1985, remaining constant until the early 2010s. Del Negro et al. (2020) even go as far as to report that there exists "overwhelming evidence in favor of a flatter price Phillips curve" (Del Negro et al., 2020, p. 302), leading to a more Keynesian economy. Galí and Gambetti (2019), using US data, find a "substantial decline" (Galí & Gambetti, 2019, p. 12) in their driving variable coefficients, confirming a flattening of the Phillips curve.

Despite most studies being conducted for the United States, similar studies for European countries seem to point in the same direction. Smith et al. (2025) study both the US and

European Union (EU) (still including the recently departed United Kingdom). For the EU, with data from 1986 to 2021, they find a break in 2004, resulting in two Phillips curve regimes: the Phillips curve appears to have steepened up until the early 2000s, and then it rapidly flattened. Siena and Zago (2024), studying a sample of 11 euro area countries in 2002-2018, also find that the Phillips curve has flattened, and that this phenomenon could be partially explained by changes in the labour market during the Great Recession and Sovereign Debt Crisis. They argue that the shift from routine to abstract employment is responsible for more than a quarter of the flattening of the Phillips curve they observed, and that increasing labour market fluidity, which is described as "the rate at which workers separate from employers and find other jobs" (Siena & Zago, 2024, p. 2171), is one of the major causes for the flattening of the Phillips curve.[2]

However, for the pandemic and post-pandemic period, the opposite may be true. Hobijn et al. (2023) find that while it is true that the Phillips curve had been flattening for over a decade prior to the COVID-19 pandemic, the same could not be said for the time after it. Their analysis shows that, for 29 industrialised countries (including, notably for this dissertation, the US, the UK, and Germany, besides 16 other euro area members), the recovery-period Phillips curve has steepened, even though they question whether this effect will persist. Similarly, Gudmundsson et al. (2024) notice a stark contrast in the shape of the pre- and post-COVID Phillips curves. They argue that before the pandemic, the Phillips curve was clearly downward sloping, but relatively flat, which is consistent with the views we previously discussed. By contrast, during the pandemic recovery, the Phillips curve seems to have shifted upward and steepened.

2.2. The Beveridge curve

The Beveridge curve, named after the British economist William Beveridge, was first presented analytically and empirically by Dow and Dicks-Mireaux (1958) as an indicator that could help guide Keynesian fiscal policy (Rodenburg, 2011).[3] It describes the negative relationship between job vacancies and unemployment, and has served as an important

[2] In this context, 'routine employment' refers to, for example, clerical, craft and plant occupation jobs. Contrastingly, 'abstract employment' encompasses, for instance, managerial occupations, technical and associate professionals, armed forces employment, etc.

[3] William Beveridge was the first to emphasise the coexistence of unemployment and vacancies as evidence of labour market frictions (which macro-labour then labelled as mismatch) in his 1940s writings. The first formal empirical representation, however, was due to Dow and Dicks-Mireaux (1958). The persistence of the Beveridge label is a recognition that conceptual insight and popularisation preceded and take precedence over formal empirical demonstration (see Blanchard and Diamond (1989)).

macroeconomic tool. Dow and Dicks-Mireaux (1958) calculate the relationship between unemployment and vacancies using an index of the pressure of demand for labour. The core relationship studied by the authors can be expressed as:

$$\begin{cases} d = \sqrt{\frac{uv}{s}} - u, & u > \frac{v}{s} \\ d = \frac{v}{s} - \sqrt{\frac{uv}{s}}, & u < \frac{v}{s} \end{cases} \tag{2.4}$$

Here, d is the index of pressure of demand for labour, u represents the unemployment rate, v is the vacancy rate, and s is the statement ratio (unfilled vacancies reported to employment exchanges as a proportion of true unfilled vacancies). According to Rodenburg (2011), later empirical contributions have estimated the relationship between vacancies and unemployment as:

$$\log v = \beta_0 + \beta_1 \log\left(\frac{1}{u}\right) + \epsilon \tag{2.5}$$

The analysis of aggregate labour market dynamics typically focuses on either the Phillips or the Beveridge curve (Blanchard & Diamond, 1989). However, the majority of economists have historically prioritised the Phillips curve, relegating the Beveridge curve to play "second fiddle" (Blanchard & Diamond, 1989, p. 1). Consequently, information regarding the history and development of the Beveridge curve is remarkably scarce.

The first noteworthy use of the Beveridge curve seems to come from a study conducted by the National Institute of Economic & Social Research (NIESR) between 1966 and 1970 – which Rodenburg (2011) relates with the fact that Christopher Dow was a member of the NIESR. The study's goal was to create a theoretical and empirical framework that allowed for the analysis of regional economic development in the UK (Brown, 1972), and it employed what was first called a "UV Analysis" (Brown, 1976, p. 134) – an analysis of the relationship between unemployment and vacancies – with the goal of measuring the degree of imperfection between the labour markets in different regions of the United Kingdom. The underlying motivation was to develop a way of assessing the extent to which regional differences in unemployment could be explained by labour market imperfections, rather than by variations in the level of effective demand (Brown, 1976).

Subsequently, the UV analysis appears to have gained traction, reaching the height of its popularity during the 1970s, with its simplicity and ease of use being highly valued by those wishing to study the nature of unemployment. Its adoption was not uniform, though: while the UV analysis was common in European countries, as well as in Japan, in the US the Phillips

curve remained the preferred framework for the analysis of unemployment (Rodenburg, 2011).

Despite not achieving major breakthroughs in the US, the UV analysis still helped revolutionise economic thought by giving empirical support to new labour market equilibrium theories, such as the search and matching models (Rodenburg, 2011). In fact, the often-used model developed by Pissarides (2000) – popular enough to warrant the title of "workhorse of modern labor and macroeconomics" (Figura & Waller, 2022, p. 2) – has the Beveridge curve as its basis.

Notwithstanding its apparent relevance, analyses of the Beveridge curve seemingly lost popularity in the 1980s, with the paradigm shift from Keynesian to neoclassical economics. In recent decades, however, there seems to have been a renewed interest in the Beveridge curve (Rodenburg, 2011), which has yielded some interesting conclusions.

Recent studies suggest that during deep recessions, the Beveridge curve tends to shift to the right, implying a higher unemployment rate for any given vacancy rate. Hobijn and Şahin (2013) are among those who come to this conclusion. They study the post-GFC rightward shifts of the Beveridge curve, for a set of OECD countries, and conclude that they are derived from a decline in measured matching efficiency (although this effect is partially offset by a drop in the quits rate). Moreover, they also note that policies aimed at easing the burden of unemployment (e.g., increasing the generosity and duration of unemployment insurance) further contribute to the rightward shift of the Beveridge curve. Lastly, they find that heavy employment losses in the construction sector during the GFC were one of the main structural factors leading to that shift. Their results hold for the UK and the US, but not for Germany, where the Beveridge curve remained somewhat stable. Similar conclusions are drawn by Bonthuis et al. (2016) for the aggregate euro area Beveridge curve. They also find a significant outward shift of the curve since the start of the Great Recession, as a result of an increase in labour market mismatch, and determine that the poor performance of the construction sector was one of the structural issues that led to that shift. In addition, they suggest that these movements of the Beveridge curve could be mitigated by changes in certain characteristics of the labour force, such as a lower share of low-skilled workers and a higher share of women in the labour force. Their German Beveridge curve runs counter to the trend, even suggesting an inward shift, which they attribute to a lagged effect stemming from the mid-2000s Hartz labour reforms, in conjunction with the extensive use of short-

time working schemes.[4] Regarding the US, Benigno and Eggertsson (2024) also sustain the hypothesis of an outwardly shifted Beveridge curve after the Great Recession. Focusing on the pandemic period, they note a period of substantial instability of the Beveridge curve in the 2020s. The US Beveridge curve began by shifting outward in April 2020, during the onset of the COVID pandemic. This shock led to a drop in matching efficiency and a rise in the fraction of labour force participants unattached to a firm.[5] The market quickly recovered, however: matching efficiency slowly began returning to normal levels and the portion of unattached workers started decreasing. This led to a stabilisation of the Beveridge curve by November 2020. At the end of 2022, the effects of the economic recovery on matching efficiency and labour participation led the Beveridge curve to shift to the left, where it rested only slightly to the right of its pre-COVID position.

During the pandemic, Beveridge curve analyses became quite popular in the US, with several authors resorting to the vacancy-unemployment relation to study the possibility of post-pandemic soft landings. Figura and Waller (2022) find evidence of a very steep Beveridge curve at the highest levels of vacancies reached during the pandemic for the US. In contrast, they note that the British Beveridge curve appeared to be flattening. Overall, they conclude that, although initially plausible, the prospect of a soft landing for the US has become less likely due to developments in the labour market – particularly with regard to layoffs – and the continued persistence of inflation above target, thereby casting doubt on the projections of "most professional forecasters" (Figura & Waller, 2022, p. 26). In turn, Bok et al. (2022) find that unemployment-vacancy combinations at the time of the pandemic were quite close to their pre-COVID locations along the Beveridge curve, lying on its steeper portion. Much like Figura and Waller (2022), they find a markedly steep Beveridge curve, especially when unemployment is low and vacancies high. Their conclusion is similar to Figura and Waller (2022): an analysis of the Beveridge curve suggests that a soft landing is possible, but highly dependent on the evolution of layoffs.

[4] Germany's short-time working schemes (Kurzarbeit) serves as an internal adjustment mechanism that allows firms to adjust labour input instead of adjusting the number of workers (Bonthuis et al., 2016). Through it, firms reduce their employees working hours instead of dismissing them. The firms pay their employee 100% of the time worked, while the government provides the employee with Kurzarbeitgeld, a subsidy equal to 60% of their pay for the time they did not work.

[5] Benigno and Eggertsson (2024) consider as unattached labour force participants individuals who were previously unemployed, individuals who were laid off, people entering the labour force, and individuals transitioning between jobs.

2.3. The VU ratio Phillips curve

In the previous sections we described the evolution and separate use of the Phillips and Beveridge curves in economic analysis. In this section, we focus on whether integrating knowledge from both may effectively improve analyses of macroeconomic conditions and, in particular, inflation dynamics.

As mentioned in Section 2.1, the original Phillips curve was the subject of criticism, and from it, several alternative formulations were derived. While Phillips (1958) originally presented the unemployment rate as the driving variable for inflation, the contributions of Phelps (1967, 1968) and Friedman (1968) shifted this link to the unemployment gap. More recently, New Keynesian formulations proposed analysing marginal costs (Galí & Gertler, 1999) or the output gap (Galí, 2015; Galí & Gertler, 1999). Another, less orthodox alternative, which seems to be gaining traction, is the vacancy-to-unemployment ratio.

Unemployment is a standard driving variable in Phillips curves, as it measures labour market conditions, which are considered relevant for inflation dynamics, through their pressure on labour costs (Abraham, 2024). It has been argued that traditional slack measures such as the unemployment rate merely capture the supply of labour, not overall market conditions, and that the VU ratio better captures the relative supply and demand for labour – which should more accurately reflect firms' hiring costs, and thereby more accurately track inflation dynamics (Barnichon et al., 2021).

The use of the VU ratio as a measure of slack is not really a recent idea. Schultze (1971) appears to have been among the first authors to observe the relationship between the Phillips and the Beveridge curves (Abraham, 2024). Schultze (1971, p. 454) states that the traditional Phillips curve "as usually drawn, collapses into one macro-relationship what is in reality the aggregation of two micro-relations", namely, the relationship of VU to wage growth and the relationship of VU to the unemployment rate.[6] Medoff and Abraham (1981) are also among the first to notice the superior performance of measures of slack that do not purely focus on labour supply. Their analysis does not focus on the VU ratio, but rather on a vacancy rate proxy: the "help wanted index", as reported by the Conference Board, divided by the number of employees on non-agricultural employment. They find that "measures of employers'

[6] Schultze (1971) remarks that the usual Phillips curve compresses into one equation what is actually a two-stage process: (i) within each labour force group, wage growth depends on the degree of excess demand, reflected in the vacancy–unemployment relation; (ii) the vacancy rate itself is related to the unemployment rate; (iii) aggregate wage inflation is then the weighted sum of these group-specific outcomes, so the overall Phillips curve is an artefact of this aggregation.

unsatisfied demand dominate unemployment rates as indicators of how labor market conditions are likely to affect wage growth" (Medoff & Abraham, 1981, p. 40), and that Phillips curves defined in terms of these relationships appear to be more stable than those defined in terms of the unemployment rate (Medoff & Abraham, 1981).

Given these papers, it might seem puzzling that the VU ratio or another measure of slack that accounts for the demand for labour has not been used in most of the literature on inflation dynamics. According to Abraham (2024), there may be two possible explanations for this. One is the relatively thin theoretical underpinnings of these early papers – with such theory appearing only later in the 1980s, with search and matching models of the labour market. Another is the lack of data to empirically pursue such a framework. In the US, the Bureau of Labor Statistics – the public department responsible for collecting data on job vacancies – was granted funding for such data collection only in 1998 (Abraham, 2024).

More recently, scholars have increasingly recognised the potential advantages of employing the VU ratio as an alternative measure of labour market slack. Notable proponents include Barnichon and Shapiro (2022, 2024), who find that the VU ratio provides "the most accurate forecasts of future price and wage pressures" (Barnichon & Shapiro, 2022, p. 4). Barnichon and Shapiro (2024) contend that without shifts in the Beveridge curve, the VU ratio and the unemployment rate should provide similar information, as they would move in tandem and therefore capture labour market tightness equally well. In contrast, when the Beveridge curve is unstable, the VU ratio may prove more informative, as it reflects both movements along the curve and structural shifts in it. Critically, it more accurately reflects changes in matching efficiency, which Barnichon and Shapiro (2024) find highly correlated with inflation. Ball et al. (2022) also advocate for the use of the VU ratio. In their analysis of inflation dynamics in the United States during the COVID-19 pandemic, they find that the VU ratio accounts for a substantial proportion of the rise in inflation, describing inflation dynamics more effectively than the unemployment rate. Furman and Powell (2021) adopt a related but distinct approach by utilising the unemployment-to-vacancies ratio. They find that this measure serves as a better predictor of CPI inflation, when compared to the quits rate (which they find to be the best predictor for nominal wage growth) and the prime-age nonemployment rate (their best predictor for real wage growth).

3. Methods and data

In this section, we outline our empirical approach. Section 3.1 presents the econometric methods. Section 3.2 describes our data.

3.1. Methods

This section outlines the methods employed in our analysis. Subsection 3.1.1 describes the econometric specification and the estimation of the Phillips and Beveridge curves. Subsection 3.1.2 discusses the structural break tests that will allow us to assess the stability of those curves. Finally, subsection 3.1.3 presents the framework for subsample estimation.

3.1.1. Specification and estimation of the Phillips and Beveridge curves

Our empirical analysis is centred on both the Phillips and Beveridge curves across a selection of regions. We estimate, for each region, one Beveridge curve and two Phillips curves, each employing a different measure for slack.

Regarding the Beveridge curve, we adopt a simplified, linear version of equation 15 of Abraham (1987):

$$v_t = k + \beta u_t + \epsilon_t \tag{3.1}$$

where v_t denotes the vacancy rate, u_t the unemployment rate, and ϵ_t is an error term. Kapa is a constant term, and beta is the slope.

By adopting a linear specification, we deviate from the original nonlinear specifications described in equations (2.4) and (2.5) as well as from more complex models found in recent literature (such as Benigno and Eggertsson's (2024) equation (6) or Barnichon and Shapiro's (2024) equation (15)). The choice of a linear formulation stems from the motivation and objectives at the core of this dissertation. As we wish to test whether the Beveridge curve – as well as the standard Phillips curve and the *Phillips-meets-Beveridge* Phillips curve – have been stable, we avoid nonlinear specifications that could mask economically relevant structural instabilities, given the well-known observational equivalence between nonlinear and unstable linear relations, *i.e.* the potential confusion between nonlinearity and structural instability. Moreover, a linear specification facilitates comparability across the different curves under consideration. Since the Phillips curve is typically estimated in a linear form, adopting a similar approach for the Beveridge curve ensures coherence and consistency in the empirical

framework.

For the Phillips curve, we estimate a model that draws from both the NKPC tradition (in the style of, for example, Galí and Gertler (1999) and Galí (2018)) and the triangle model of Gordon (1977a, 1977b, 1981, 1982). Specifically, we depart from the conventional NKPC by not using the output gap as a measure for slack, and by incorporating a supply shock variable[7] from the triangle model:

$$\pi_t = k + \zeta x_t + \beta E_t(\pi_{t+4}) + \gamma SS_t + \epsilon_t \tag{3.2}$$

Here, π_t represents inflation, x_t is the measure of economic slack, and $E_t(\pi_{t+4})$ captures 1-year (4 quarters) ahead inflation expectations. One year ahead expectations were chosen given their prominent role in inflation modelling, as documented by Fuhrer (2012) and Fuhrer et al. (2012), and are measured, where possible, via surveys, following the approach of Coibion and Gorodnichenko (2015). SS_t denotes supply shocks, proxied by energy inflation, while ϵ_t is the error term.

We use two alternative measures of economic slack. The first follows the traditional Phillips (1958) approach, using the unemployment rate (u_t) as driving variable for inflation. The second utilises the VU ratio (VU_t), calculated as the number of vacancies divided by the number of unemployed, as driving variable. Our inspiration for this measure is Barnichon and Shapiro (2024), although it had been suggested as an alternative way of measuring economic slack prior to their work (Ball et al., 2022; Barnichon & Shapiro, 2022; Medoff & Abraham, 1981). According to Barnichon and Shapiro (2024), this alternative measure should perform better than traditional measures of slack. A key objective of this dissertation is, precisely, to test whether the *Phillips-meets-Beveridge* Phillips curve is more stable and has a superior ability to explain inflation dynamics than the standard Phillips curve.

We adopt a linear specification of the Phillips curve for the same reason explained above for the Beveridge curve: we aim to test its structural (in)stability, and so we avoid specifications that could mix nonlinearity with instability. In the case of the Phillips curve, it could be argued that the linear formulation has even more support than in the case of the Beveridge curve: while Phillips' original formulation was nonlinear and there has been a large literature on the nonlinear Phillips curve (see e.g. Aguiar and Martins (2005) and the

[7] This particular departure from the standard New Keynesian Phillips Curve is not far-fetched. In fact, the use of controls for cost-push shocks is utilised by Coibion and Gorodnichenko (2015) in their equation (1), as well as by Woodford (2003) in equation (2.1) of Chapter 7.

references therein), the vast majority of research and of macro models postulate linear Phillips curves.

Equations (3.1) and (3.2) are estimated via OLS. To address potential autocorrelation and heteroscedasticity, we apply the heteroskedasticity and autocorrelation consistent (HAC) covariance matrix estimator proposed by Newey and West (1987).

3.1.2. Testing for structural breaks

To examine whether the structure of the Phillips and Beveridge curves has undergone changes over time, we test our estimated relationships for structural breaks using the methods developed by Bai and Perron (1998, 2003). This approach enables us to identify both the number and timing of breakpoints, which are unknown to us *a priori*.

Specifically, we employ Bai and Perron's (1998) sequential supF-test, recommended by Bai and Perron (2003). The Bai and Perron (1998) sequential procedure tests the null hypothesis of ℓ structural breaks against the alternative of $\ell+1$ breaks. It begins by estimating a model with no breaks, and then sequentially adds breaks. At each step, if the null hypothesis of no additional breaks is rejected, a new breakpoint is added at the location where the evidence for a break is strongest, and the procedure is repeated until the null hypothesis is no longer rejected.

We allow for a maximum of five structural breaks and adopt a trimming of 15%, as recommended by Bai and Perron (2003). In practice, this imposes minimum regime lengths that vary by region due to differing sample sizes: 12 quarters for Germany, 11 quarters for the euro area, and 14 quarters for both the United Kingdom and the United States.

We test for structural breaks only in the slopes of the Beveridge and Phillips curves, the coefficients beta in (3.1) and (3.2). Such a choice stems from the motivation and objectives of this dissertation. First, we aim to assess the stability of the Beveridge and Phillips relations, *i.e.* of the relation between vacancies and unemployment, unemployment and inflation, and the VU ratio and inflation; we thus wish to avoid any confusion between changes in the slope of the curves and in the position of the curves. Second, we aim at assessing whether the *Phillips-meets-Beveridge* Phillips curve, with a Beveridge-motivated driving variable, describes inflation dynamics better than the standard unemployment-based Phillips curve; we thus wish to isolate the (in)stability and relative performance of the alternative labour market slack indicators.

3.1.3. Subsample estimation

Given the timing for the structural breaks identified by the Bai-Perron multiple breakpoint tests, we then proceed to re-estimate the Beveridge and the two Phillips curves over the implied subsample periods.

Consistent with our approach for structural breaks testing explained in Section 3.1.2, in our subsample regressions, we hold the coefficients on all other explanatory variables (controls) at their full-sample estimates: only the coefficients on the driving variables (betas in (3.1) and (3.2)) are permitted to vary across subsamples.

This approach allows us to examine how the responsiveness of the dependent variables to the main driving variables has evolved over time *ceteris paribus*, *i.e.* keeping constant their responsiveness to the controls. While the assumption that the other coefficients remain constant is not strong in the case of the Beveridge curve – where there are no control variables and the hypothesis regards only the intercept – it may be considered rather strong in the case of the Phillips curve. Our assumption has two main motivations. First, as explained above, we wish to compare the ability of the standard measure of slack (unemployment) and the *Phillips-meets-Beveridge* measure (VU ratio) to model inflation dynamics; therefore, we wish to keep constant the role of the controls. Second, freely estimating all Phillips curves parameters poses difficult econometric problems in many identified subsamples, which are rather short.

3.2. Data

We empirically examine the Phillips and Beveridge curves of four economies: Germany, the euro area, the United Kingdom, and the United States. To do so, as a rule, we use time series from seven macroeconomic variables: inflation, inflation expectations, energy inflation (as a proxy for supply shocks), unemployment and vacancies (both rate and level), and employment.

Our time series for the macroeconomic variables are largely comparable across regions, with the exception of the data on vacancies. In Germany, vacancy figures are collected at the state level rather than at the national level, and vacancy rates must be derived manually. In the euro area, vacancy data are classified in a manner that necessitates manual computation. By contrast, in the United Kingdom and the United States, vacancy rates are calculated using methods that differ from those employed in the euro area. Specifically, euro area member states compute the job vacancy rate as the ratio of vacancies to the total number of posts

(both occupied and vacant). The UK's Office for National Statistics, however, expresses vacancies per 100 jobs, while the US Bureau of Labor Statistics calculates the vacancy rate as the ratio of vacancies to the sum of vacancies and employment.

We use quarterly data, in line with the literature (see *e.g.*, Barnichon and Figura (2010) and Bonthuis et al. (2016) for the Beveridge curve, Coibion and Gorodnichenko (2015) and Del Negro et al. (2020) for the Phillips curve). Although most of our time series are available at the monthly frequency, both the Beveridge and Phillips curves are seen as business cycle relationships, which are typically more relevant once monthly noise has been corrected for.

The sample period ends in 2024Q4 for all four regions, and starts as close as possible to the year 2000, depending on the availability of data for all time series in each region.

3.2.1. Germany

German data come primarily from Destatis, the Federal Statistical Office of Germany. The only exception are inflation expectations, which are taken from the ECB's Survey of Professional Forecasters, retrieved from the ECB Data Portal.

German inflation (π) is the annual rate of change of the consumer price index (CPI)[8], and energy inflation (Energy) is the analogous rate for the energy component of the CPI[9]. Unemployment data for Germany adhere to the International Labour Organization's (ILO) definition, encompassing individuals aged 15 to 74 who are not economically active but have actively sought employment within the four weeks preceding the Labour Force Survey and are available to commence work within two weeks. Unemployment data are sourced from the Labour Force Survey. The unemployment level (U)[10] denotes the absolute number of unemployed individuals, while the unemployment rate (URate)[11] is their proportion to the economically active population. Vacancy data for Germany comprise the number of registered job openings, including positions subject to social insurance contributions, marginal employment[12], and other roles intended to last more than seven calendar days, provided these have been reported to employment agencies and job centres. The job vacancy rate (VRate) is defined as the proportion of vacant jobs (V)[13] relative to the total number of

[8] Destatis table 61111-0002.
[9] Destatis table 61111-0006, under the code CC13-65D.
[10] Destatis table 13231-0001.
[11] Destatis table 13231-0001.
[12] Marginal employment in Germany corresponds to either "mini-jobs", which correspond to jobs where the average wage is limited to a maximum of €538/month, or short-term employment, in which work is limited to a maximum of three months or 70 working days within a calendar year.
[13] Destatis table 13211-0008.

job posts.

Destatis does not publish data on occupied job posts, and the alternative – the Eurostat database – does not provide seasonally adjusted values for a long enough time period. As such, instead of using the Eurostat's standard formula for the job vacancy rate,

$$VRate = \frac{Number\ of\ job\ vacancies}{Number\ of\ job\ vacancies + Number\ of\ occupied\ posts} * 100 \quad (3.3)$$

we opt to use the alternative formulation

$$VRate = \frac{Number\ of\ job\ vacancies}{Number\ of\ job\ vacancies + Number\ of\ employed} * 100 \quad (3.4)$$

Evidently, employment is not the same as occupied posts. For instance, individuals holding multiple jobs are recorded statistically as a single employed person, despite occupying more than one post. Despite this limitation, we find employment to be a reasonable approximation.[14]

To obtain the vacancy rate using this formula, we require data on employment (E)[15]. We again rely on Destatis, which defines employed persons as individuals aged over 15 who, during the Labour Force Survey reference period, worked for remuneration for at least one hour, undertook an internship, engaged in marginal employment, or performed compulsory military or civil service.

To measure inflation expectations (π^e), the preferable time series – in the spirit of Coibion and Gorodnichenko (2015) – would be that of the Bundesbank Survey on Consumer Expectations. However, such a survey has only been conducted since 2019, and so the available data are insufficient for our econometric purposes. We therefore rely on inflation expectations from the Survey of Professional Forecasters (SPF)[16], conducted quarterly by the European Central Bank (ECB) since 1999. The survey gathers responses from expert economists from financial and non-financial institutions, who utilise varying forecasting methodologies to respond to a number of questions relating to their expectations on consumer price inflation, wage growth, real GDP growth and unemployment in the euro

[14] In fact, the US Bureau of Labor Statistics uses this exact formula in its computation of the homologous Job Openings Rate, collected in the Job Openings and Labor Turnover Survey. The specific formula can be consulted at https://www.bls.gov/help/def/jt.htm.
[15] Destatis table 13231-0001.
[16] Data from the Survey of Professional Forecasters is made publicly available by the European Central Bank at https://www.ecb.europa.eu/stats/ecb_surveys/survey_of_professional_forecasters/html/index.en.html.

area for different horizons (de Vincent-Humphreys et al., 2019). We adopt the one-year-ahead point expectations for the euro area inflation as the measure for inflation expectations in Germany. Given that Germany's inflation weighs almost 29% in the aggregate euro area HICP on average in 1999-2024, we argue that one can reasonably proxy German inflation expectations with euro area inflation expectations.[17]

The majority of the data are collected at a monthly frequency, with the exception of the SPF, which is reported quarterly. To convert monthly data into a quarterly format, we calculate arithmetic quarterly averages over calendar quarters, defined as follows: January-March (Q1), April-June (Q2), July-September (Q3), and October-December (Q4). With the exception of the vacancies data, all German data are measured at the national level. Vacancy data, however, are collected at the state level. As such, our calculated national-level vacancy figures correspond to the sum of monthly vacancies across the 16 states, followed by the computation of quarterly arithmetic averages.

Given the availability of data for all time series, our final sample contains 80 observations, from 2005Q1 to 2024Q4. The following table contains the descriptive statistics for each time series.

Table 1 – Germany descriptive statistics 2005Q1-2024Q4

Variable	π	URate	π^e	Energy	U	V	E	VRate
Mean	0.0203	0.0529	0.017	0.0405	2.1831	0.5477	39.5321	0.0134
Median	0.0163	0.0457	0.0157	0.0278	1.8850	0.5115	39.3950	0.0128
Max.	0.0857	0.112	0.0476	0.3384	4.4967	0.8787	43.2367	0.0202
Min.	-0.0053	0.029	0.0076	-0.0912	1.2500	0.1978	35.5700	0.0055
Std. Dev.	0.0178	0.0238	0.0062	0.0869	0.9243	0.1879	2.2291	0.004
Skew.	1.9918	1.0703	2.2682	1.1846	1.1355	0.0010	-0.0234	-0.0654
Kurtosis	7.1278	3.0526	10.3816	4.9514	3.1879	1.7326	1.7851	1.8535
NOBS	80	80	80	80	80	80	80	80

Note: Values for U, V, and E in millions of persons.

3.2.2. Euro area

For the euro area analysis, most data were obtained from the ECB Data Portal. With the exception of inflation expectations, all ECB-sourced data originate from Eurostat. Data on total employment were retrieved directly from Eurostat.

[17] This can be corroborated by analysing Eurostat's [prc_hicp_cow] series, via the country weights for the euro area. The relevant dataset is available at https://ec.europa.eu/eurostat/databrowser/bookmark/f7a10e88-b28a-46ea-abdd-f231de4aeb67?lang=en.

Euro area inflation is the annual rate of change of the harmonised index of consumer prices (HICP)[18], and energy inflation corresponds to the year-on-year growth of its energy component[19]. Employment and unemployment data are derived from the European Union Labour Force Survey (EU-LFS). Unemployment[20] is defined as individuals aged 15-74 who were not employed during the reference week, were available to start work within two weeks, and had actively sought paid employment or self-employment in the preceding four weeks or had secured a job due to commence within three months. The unemployment rate[21] is the proportion of unemployed persons to the economically active population. Employment[22] comprises individuals aged 15 and over who, during the reference week, worked for at least one hour for pay, profit, or family gain, or who were temporarily absent from a job or business they usually perform (e.g., due to illness, leave, or holidays). The job vacancy rate[23] is the share of total posts (both filled and vacant) that are unoccupied but for which employers are actively recruiting, with the intention of filling them immediately or within a defined period. Data on job vacancies are flagged as "confidential" and as such, need to be estimated. Using Eurostat's glossary definition of the job vacancy rate, we algebraically derive the following identity:

$$Vacancies = \frac{VRate * Occupied\ Posts}{1 - VRate} \tag{3.5}$$

As data on occupied posts are also confidential, we substitute employment in place of occupied posts and adopt the following approximation:

$$Vacancies = \frac{VRate * Employment}{1 - VRate} \tag{3.6}$$

This adjustment presents similar limitations to those discussed in the German case. Nevertheless, we consider this approximation sufficiently robust for our analytical purposes.

Finally, inflation expectations come from the SPF, which we have previously described. As with Germany, we utilise the one-year-ahead point forecasts to represent expected inflation in the euro area.

[18] ECB Data Portal series ICP.M.I9.N.000000.4.ANR.
[19] ECB Data Portal series ICP.M.U2.N.NRGY00.4.ANR.
[20] ECB Data Portal series LFSI.M.I9.S.UNEMPL.TOTAL0.15_74.T.
[21] ECB Data Portal series LFSI.M.I9.S.UNEHRT.TOTAL0.15_74.T.
[22] Eurostat series lfsq_egan.
[23] ECB Data Portal series JVS.Q.I9._Z.S.JVR.BTS._T._T.

Data on employment and the job vacancy rate are available quarterly; all other variables are reported monthly. To harmonise frequencies, we compute arithmetic averages over calendar quarters.

The final dataset comprises 76 quarterly observations, spanning from 2006Q1 to 2024Q4. The following table presents the descriptive statistics for all time series.

Table 2 - Euro area descriptive statistics 2006Q1-2024Q4

Variable	π	URate	π^e	Energy	U	V	E	VRate
Mean	0.0214	0.0899	0.0170	0.0418	14.6162	2.7498	145.4309	0.0183
Median	0.0182	0.0861	0.0156	0.0218	13.9547	2.3080	144.1075	0.0160
Max.	0.0997	0.1223	0.0476	0.3963	19.7341	5.2092	156.8300	0.0330
Min.	-0.0033	0.0620	0.0076	-0.1187	10.6891	1.4265	139.3010	0.0100
Std. Dev.	0.0208	0.0180	0.0064	0.1077	2.7737	1.1002	5.0009	0.0065
Skew.	1.9208	0.2432	2.2284	1.4064	0.3554	0.8668	0.8317	0.7936
Kurtosis	7.0651	1.8209	9.9245	5.5312	1.8156	2.5378	2.6022	2.4928
NOBS	76	76	76	76	76	76	76	76

Note: Values for U, V, and E in millions of persons.

3.2.3. United Kingdom

Data for the UK come from two sources. Most time series originate in the Office for National Statistics (ONS), the United Kingdom's national statistical institute, while inflation expectations come from the Bank of England (BoE).

Inflation is the year-on-year growth rate of the consumer price index[24], and energy inflation is the annual rate of change of its respective CPI component[25]. Unemployment[26] refers to individuals aged at least 16 who are without a job, have actively sought employment within the past four weeks, and are available to start work within the next two weeks. The unemployment rate[27] is defined as the share of the economically active population that is unemployed. Vacancies[28] are defined as open positions for which employers are actively recruiting external candidates.[29]

[24] ONS series D7G7.
[25] ONS series DKL5.
[26] ONS series VACS01.
[27] ONS series MGSX.
[28] ONS series VACS01.
[29] It should be noted that ONS estimates for vacancies do not take into account the stock of vacancies in agriculture, forestry and fishing, as the small size of the sector makes it impractical to collect estimates.

Unlike other countries in the analysis, the UK vacancy rate is not derived using formulas (3.3) or (3.4). According to the OECD (2024, p. 50), "for the United Kingdom, the vacancy rate is calculated as the number of vacancies per 100 jobs". We therefore adopt this ONS-provided metric.[30]

Inflation expectations are sourced from the BoE's Inflation Attitudes Survey[31], conducted quarterly since November 1999. Initially carried out face-to-face, it has changed to an online format since May 2020. From the several questions asked, we are particularly interested in question 2a: "How much would you expect prices in the shops generally to change over the next 12 months?". The BoE reports the median of responses to this question, which we use as a proxy for inflation expectations, following Coibion and Gorodnichenko (2015).

The ONS provides monthly, quarterly, and annual series for inflation and energy inflation, whereas data on unemployment, the unemployment rate, vacancies, vacancy rate, and employment are reported as rolling three-month averages. Where quarterly estimates are available, we use them directly; for variables only available as rolling three-month averages, we extract data corresponding to calendar quarters, that is, data for January-March, April-June, July-September, and October-December. For inflation expectations, we use the BoE's published quarterly data.

Our final sample for the UK comprises 95 observations, spanning from 2001Q2 to 2024Q4. The descriptive statistics are as follows:

[30] ONS series AP2Z.

[31] Data from the Inflation Attitudes Survey is made publicly available by the Bank of England. Data up to 2025Q1 can be found at https://www.bankofengland.co.uk/inflation-attitudes-survey/2025/february-2025.

Table 3 - United Kingdom descriptive statistics 2001Q2-2024Q4

Variable	π	URate	π^e	Energy	U	V	VRate
Mean	0.0261	0.0545	0.0290	0.0553	1.7523	0.6958	0.0220
Median	0.0210	0.0510	0.0280	0.0420	1.5850	0.6540	0.0218
Max.	0.1070	0.0840	0.0490	0.5580	2.6890	1.2990	0.0379
Min.	0.0000	0.0370	0.0180	-0.1660	1.2750	0.3280	0.0100
Std. Dev.	0.0211	0.0138	0.0070	0.1294	0.4292	0.2012	0.0052
Skew.	2.0951	0.8397	0.8163	1.8781	0.9952	1.0913	0.9129
Kurtosis	7.9026	2.4160	3.1720	8.2899	2.4923	4.1743	4.5189
NOBS	95	95	95	95	95	95	95

Note: Values for U and V in millions of persons.

3.2.4. United States

US data were primarily sourced from the Federal Reserve Economic Data (FRED) database, with most series ultimately originating from the U.S. Bureau of Labor Statistics (BLS), except for inflation expectations, which are provided by the University of Michigan.

Inflation is the annual rate of change of the consumer price index[32], and energy inflation reflects the year-on-year rate of growth of its corresponding CPI component[33]. Unemployment data are drawn from the BLS' Current Population Survey, which defines unemployed individuals as those aged 16 or over who were not in employment during the reference week, were available to work, and had made at least one active effort to find employment during the survey period or were temporarily laid off and expecting recall[34]. The unemployment rate is the share of the labour force that is unemployed[35]. Vacancies are taken from data on job openings, measured as non-filled positions at the last business day of the month[36]. A position is considered open if it is established, has work available, can be filled within 30 days, and the employer is actively seeking candidates. The vacancy rate corresponds to the job opening rate, calculated as the number of job openings divided by the sum of job openings and total employment[37].

Inflation expectations were taken from the University of Michigan's Survey of

[32] FRED series CPIAUCSL.
[33] FRED series CPIENGSL.
[34] FRED series UNEMPLOY.
[35] FRED series UNRATE.
[36] FRED series JTSJOL.
[37] FRED series JTSJOR.

Consumers[38], following Coibion and Gorodnichenko (2015). This survey collects data on several key economic indicators – including our preferred measure of expectations, one-year-ahead inflation expectations – from 1978 onwards. Respondents are asked: "During the next 12 months, do you think that prices in general will go up, or go down, or stay where they are now?" and "By what percent do you expect prices to go up, on average, during the next 12 months?". The reported median response is used as the measure of inflation expectations.

All series are collected at a monthly frequency. To align them with the quarterly structure of the analysis, we compute arithmetic averages over calendar quarters, as previously described.

The final US dataset comprises 96 quarterly observations, spanning from 2001Q1 to 2024Q4, the period for which complete data are available for all variables of interest. Descriptive statistics are displayed in the following table.

Table 4 – US descriptive statistics 2001Q1-2024Q4

Variable	π	URate	π^e	Energy	U	V	VRate
Mean	0.0255	0.0576	0.0310	0.0420	8.9526	5.4088	0.0364
Median	0.0218	0.0520	0.0292	0.0352	7.9805	4.6165	0.0330
Max.	0.0859	0.1300	0.0533	0.3540	20.5550	11.6780	0.0720
Min.	-0.0161	0.0350	0.0107	-0.2516	5.8260	2.3520	0.0180
Std. Dev.	0.0176	0.0196	0.0072	0.1270	2.9842	2.3133	0.0128
Skew.	1.1864	1.1345	1.1045	0.0381	1.2969	1.0763	1.0637
Kurtosis	5.5753	3.8580	4.8184	2.7497	4.2889	3.4082	3.6298
NOBS	96	96	96	96	96	96	96

Note: Values for U and V in millions of persons.

[38] Data on the University of Michigan's Survey of Consumers is publicly available at https://data.sca.isr.umich.edu/data-archive/mine.php. Our data on inflation expectation stems from Table 32: Expected Change in Prices During the Next Year.

4. Results

This section presents and discusses the key findings of our empirical analysis. We begin by examining the full-sample estimates of the Beveridge and Phillips curves in Section 4.1. We then turn to the structural break tests in Section 4.2 and to the subsample estimates in Section 4.3. Finally, Section 4.4 contains a brief discussion of our main results.

4.1. Full sample

This section presents the results of the econometric estimation of the Phillips and Beveridge curves described in Section 3.1.1. We begin by discussing the Beveridge curve results, before moving to the standard (unemployment rate) and then to the *Phillips-meets-Beveridge* (VU) Phillips curve.

4.1.1. Beveridge curves

The estimates of the intercept and slope of the Beveridge curve are presented in Table 5. They are statistically significant, and confirm a negative relationship between vacancies and unemployment, in line with the seminal findings of Dow and Dicks-Mireaux (1958).

The estimates suggest that the responsiveness of vacancies to the unemployment rate is notably stronger in the United States than in the European regions that we consider. This outcome is not unexpected, given the widely held view of the US labour market as more dynamic and flexible than its European counterpart (Nickell, 1997). Among the European economies, the United Kingdom exhibits the steepest slope of the Beveridge curve, likely reflecting its greater labour market flexibility within the European context (Nickell, 1997).

Conversely, Germany displays the flattest Beveridge curve, indicating a weaker response of the vacancy rate to changes in the unemployment rate. This finding is somewhat unexpected, considering the substantial labour market reforms undertaken in Germany during the early 2000s, notably the Hartz reforms. While these reforms are credited with improving key aspects of the labour market – such as matching efficiency via Hartz III (Burda & Seele, 2020) – it is possible that the slope did steepen only post-reform and appears comparatively flat in the overall sample.

Table 5 - Beveridge curve estimates

Dependent Variable (v)	v = k + α*u				
	Period	k	α	R^2	NOBS
GER	2005:1-2024:4	0.0212***	-0.1466***	0.7798	80
EZ	2006:1-2024:4	0.0394***	-0.2339***	0.4170	76
UK	2001:2-2024:4	0.0403***	-0.2995***	0.5301	95
USA	2001:1-2024:4	0.0584***	-0.3831***	0.3431	96

Notes: *, **, and *** denote significance at the 10, 5 and 1 percent level, respectively. Standard errors are computed using the Newey and West (1987) HAC estimator of the covariance matrix.

4.1.2. Standard Phillips curves

Turning to the Phillips curve, our estimates (displayed in Table 6) confirm the expected negative relationship between unemployment and inflation, as originally posited by Phillips (1958). Across all regions, the Phillips curves appear relatively flat, a finding that might be consistent with the hypothesis of a flattening Phillips curve, as discussed in Section 2.1. However, confirmation of this hypothesis requires further examination of the subsample estimates, and a comparison of their evolution throughout time.

A more detailed look at the results indicates that all slope coefficients are statistically significant, with the German and the US coefficients significant at the 1% level, and the euro area and UK coefficients significant only at the 10% level (with p-values of 0.0690 and 0.0766, respectively). The euro area exhibits the flattest unemployment rate Phillips curve in the sample, while Germany and the United Kingdom appear to have comparatively steeper curves. The particularly flat slope observed for the euro area may be attributable to cross-country heterogeneity within the monetary union, which could bias the aggregate estimate downward relative to the true underlying relationship (Schuffels et al., 2024).

The estimated coefficients for inflation expectations are not statistically distinguishable from 0.99 - the standard value in literature - at the 95% confidence level for all the four regions. The estimates of the coefficients associated with supply shocks (proxied by energy inflation) are positive and significant across all regions and are quantitatively in line with the literature.

Table 6 – Standard (unemployment rate) Phillips curve estimates

Dependent Variable (π)	$\pi = k + \alpha*u + \beta*E(\pi) + \gamma*SS$						
	Period	**k**	**α**	**β**	**γ**	**R^2**	**NOBS**
GER	2005:1-2024:4	0.0098**	-0.2509***	0.9922***	0.1686***	0.8096	80
EA	2006:1-2024:4	0.0117	-0.1744*	1.0975***	0.1608***	0.8128	76
UK[39]	2001:2-2024:4	-0.0181***	-0.2605*	1.6703***	0.0971***	0.8484	95
USA	2001:1-2024:4	0.0011	-0.2475***	1.1593***	0.0637***	0.8608	96

Notes: *, **, and *** denote significance at the 10, 5 and 1 percent level, respectively. Standard errors are computed using the Newey and West (1987) HAC estimator of the covariance matrix.

4.1.3. *Phillips-meets-Beveridge* Phillips curves

In Table 7, we turn to the alternative – *Phillips-meets-Beveridge* – Phillips curve formulation.

As expected, the estimates of the VU ratio coefficients are positive – a higher VU ratio implies a tighter labour market and an upward pressure on wages and prices – and relatively small. The euro area exhibits the largest estimates, while the United States displays the smallest one.

The estimates of the inflation expectations coefficients are, in this specification, overall smaller than in the standard Phillips curve model, but remain within acceptable parameters – comprising the theoretical value of 0.99, at the 95% significance level.

The estimates for the coefficients associated with supply shocks are all statistically significant and quite similar to the ones obtained for the standard Phillips curve specification.

[39] The UK specification includes additional control variables to account for the greater openness of the UK economy. These include a measure of relative import prices (Batini et al., 2005), exchange rates, degree of openness (Abbas et al., 2016) and food inflation (Topalova et al., 2023).

Table 7 - Phillips-meets-Beveridge (VU) Phillips curve estimates

Dependent Variable (π)	π = k + φ*VU + β*E(π) + γ*SS						
	Period	**k**	**φ**	**β**	**γ**	**R^2**	**NOBS**
GER	2005:1-2024:4	-0.0112**	0.0305**	0.9123***	0.1509***	0.8036	80
EZ	2006:1-2024:4	-0.0106**	0.0518**	0.9054***	0.1453***	0.8497	76
UK[40]	2001:2-2024:4	-0.0418***	0.0299***	1.5467***	0.0855***	0.8810	95
USA	2001:1-2024:4	-0.0111*	0.0153***	0.7318***	0.0736***	0.9044	96

Notes: *, **, and *** denote significance at the 10, 5 and 1 percent level, respectively. Standard errors are computed using the Newey and West (1987) HAC estimator of the covariance matrix.

To compare the ability of the *Phillips-meets-Beveridge* and the standard Phillips curve to model inflation dynamics, in Table 8 we present the sum of squared residuals (SSR) of both models for the four regions.[41] The table shows that the SSR of the *Phillips-meets-Beveridge* curves are substantially smaller than the ones of the standard Phillips curve – except for Germany, where they hardly change (increasing by 3.2%). The largest improvement occurs in the US, where the SSR decreases by 31.3%. Given that the only difference between Phillips curve models lies in the measure of slack, these results show that the VU ratio is overall better – and, even for Germany, is not worse – at capturing inflation dynamics than the more traditional unemployment rate. These conclusions are consistent with the results of Barnichon and Shapiro (2024) for the case of the US, obtained with slightly different methods. Overall, we may conclude that the evidence pointing to a superior ability of the VU ratio, compared with the unemployment rate, to model inflation dynamics, seems to be robust.

[40] The V/U specification of the Phillips curve also contains the additional controls previously mentioned in the Unemployment Rate specification.

[41] Barnichon and Shapiro (2024) compare their specifications via the relative change in Mean Square Errors (MSE). As both our models were estimated on identical datasets for each country, our SSR are directly comparable without normalisation. We therefore opted to compare models using the relative change in SSR. We verified that conclusions are consistent when using relative MSE.

Table 8 - Sum of squared residuals for the standard and Phillips-meets-Beveridge Phillips curves (full sample)

Country	SSR Phillips curves		Relative Change
	Standard (U)	Phillips-meets-Beveridge (VU)	
GER	0.0048	0.0049	3.2%
EA	0.0061	0.0049	-19.8%
UK	0.0063	0.0050	-21.5%
USA	0.0041	0.0028	-31.3%

4.2. Structural breaks

We now examine the (in)stability of the Beveridge Curve, as well as of both our Phillips curve specifications, by means of structural stability tests. Results are in Table 9.

Regarding the Beveridge curve, we observe that most countries exhibit a structural break around the time of the Global Financial Crisis, with Germany registering the earliest break and the euro area the latest (indeed, more aligned with the European Sovereign Debt Crisis than the GFC itself). Furthermore, both the euro area and the US display a break during the COVID years. The United Kingdom stands out as an exception, exhibiting a notably stable Beveridge curve with no detected breaks throughout the 2001–2024 period.

Turning to the standard (unemployment rate) Phillips curves, the most striking results arise for Germany and the euro area, neither of which display any breaks over the sample period. These findings are consistent with Hindrayanto et al. (2019), who found no evidence of significant changes in the slope of the euro area Phillips curve in the post-GFC period. Moreover, this does not necessarily contradict the hypothesis of a continued flattening, nor the findings of Hobijn et al. (2023) regarding a post-pandemic steepening: while no structural breaks were detected in the slope of the Phillips curve during this period, the data may still be consistent with a gradual flattening over time that does not manifest as a discrete break.

In contrast, the United Kingdom and United States register a single structural break in the third quarter of 2021, which is closely aligned with the results in Hobijn et al. (2023) and the possibility of a steeper Phillips curve during the pandemic – a hypothesis to be assessed in the next section.

The last columns in Table 9 indicate that the *Phillips-meets-Beveridge* (VU) Phillips curve has overall been less stable: in all regions – with the exception of the UK, whose breakpoints remain unaltered – we detect additional breakpoints compared to the ones detected in the standard (U) Phillips curve. Notably, all regions show evidence of a break during the

pandemic period, indicating that the consequences of COVID on the relation between inflation and the tightness of the labour market measured by the VU ratio were felt globally (differently from the cases of Germany and the euro area regarding the relation between inflation and the unemployment rate). Overall, except for the UK, we conclude that the *Phillips-meets-Beveridge* (VU-based) Phillips curve appears more prone to structural shifts than the standard (U) Phillips curve – a result not easily reconciled with the one that the full-sample SSR of the latter is higher than that of the former.

Table 9 - Structural break Beveridge and Phillips curves

Country	Beveridge Curve		Standard Phillips Curve (U)		Phillips-meets-Beveridge Phillips Curve (VU)	
	Break Date	Period	Break Date	Period	Break Date	Period
GER	2008:4	2005:1-2008:4 2009:1-2024:4	No breaks		2016:2 2021:3	2005:1-2016:2 2016:3-2021:3 2021:4-2024:4
EZ	2010:4 2017:1 2021:3	2006:1-2010:4 2011:1-2017:1 2017:2-2021:3 2021:4-2024:4	No breaks		2022:2	2006:1-2022:2 2022:3-2024:4
UK	No breaks		2021:3	2001:2-2021:3 2021:4-2024:4	2021:3	2001:2-2021:3 2021:4-2024:4
USA	2009:1 2020:2	2001:1-2009:1 2009:2-2020:2 2020:3-2024:4	2021:3	2001:1-2021:3 2021:4-2024:4	2013:2 2021:2	2001:1-2013:2 2013:3-2021:2 2021:3-2024:4

Notes: The number of breaks and corresponding breaks are chosen based on the ℓ vs. $\ell + 1$ breaks test proposed by Bai and Perron (1998, 2003). The trimming parameter is set to 15%.

4.3. Subsamples

We now turn to the results of the subsample estimations, conducted according to the methods outlined in Section 3.1.3. We begin by discussing the Beveridge curve results, before moving to the standard (unemployment rate) and the *Phillips-meets-Beveridge* (VU) Phillips curve.

4.3.1. Beveridge curves

Regarding the Beveridge curve, we observe that in Germany and the euro area its slope appears to have undergone a steepening process over time. In contrast, we find no evidence

of any significant increase in the sensitivity of the vacancy rate to changes in the unemployment rate for the United Kingdom and the United States.

Table 10 - Beveridge curve subsample estimates

Dependent Variable (v)	v = k + α*u			
	Break Date	Period	k	α
GER	2008:4	2005:1-2008:4	0.0170***	-0.0878***
		2009:1-2024:4	0.0259***	-0.2621***
EZ	2010:4	2006:1-2010:4	0.0140***	-0.0239
	2017:1	2011:1-2017:1	0.0309***	-0.1420***
	2021:3	2017:2-2021:3	0.0380***	-0.2025**
		2021:4-2024:4	-0.0182	0.7238
UK	No breaks			
USA	2009:1	2001:1-2009:1	0.0526***	-0.4492***
	2020:2	2009:2-2020:2	0.0540***	-0.3093***
		2020:3-2024:4	0.0694***	-0.2684**

Notes: *, **, and *** denote significance at the 10, 5 and 1 percent level, respectively. Standard errors are computed using the Newey and West (1987) HAC estimator of the covariance matrix. The number of breaks and corresponding breaks are chosen based on the ℓ vs. $\ell + 1$ breaks test proposed by Bai and Perron (1998, 2003). The trimming parameter is set to 15%.

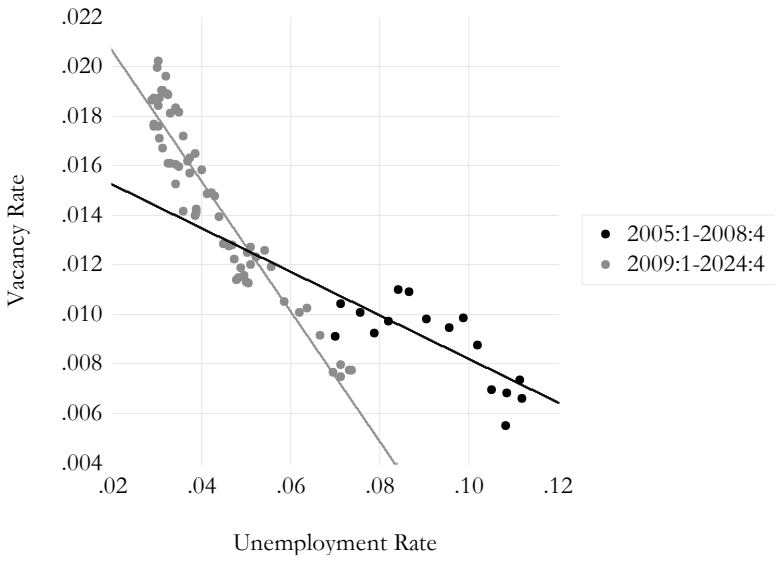
Data for Germany suggest the existence of two distinct Beveridge regimes over the 2005-2024 period, with a structural break around the time of the Great Financial Crisis. Following this episode, the German Beveridge curve appears to have steepened – a result also found by Consolo and Da Silva (2019), even though they find the break in 2013. This suggests that the German labour market became more responsive in the aftermath of the crisis. Moreover, Bonthuis et al. (2016) and Pissarides (2013) argue that the curve shifted inwards.

These changes are arguably related to the earlier 2003-2005 Hartz reforms. Designed to improve labour market flexibility and address the rise in unemployment, lack of competitiveness, and slow growth registered in Germany in the early 2000s, those reforms relaxed employment protection, lifted labour contract restrictions, reduced labour costs, improved matching efficiency, and drastically reduced unemployment benefits (Pissarides, 2013). The Hartz reforms may have had lagged results, only fully noted sometime after their implementation (Bonthuis et al., 2016). Indeed, it was established that the subsequent series

of labour supply shifts in the 2003-2010 period contributed to higher job matching efficiency (particularly through the reforms introduced by Hartz III, implemented in 2004), and to a durable increase in labour force participation and reduction in unemployment that persisted in spite of the Great Recession (Burda & Seele, 2020). Enhanced matching efficiency likely accelerated the rate at which vacancies were filled, leading to a more rapid decline in the vacancy rate as unemployment rose. In addition, the increasing use of short-time working schemes during the crisis provided firms with internal adjustment mechanisms to manage labour input, thereby reducing the need to cut jobs (Bonthuis et al., 2016).

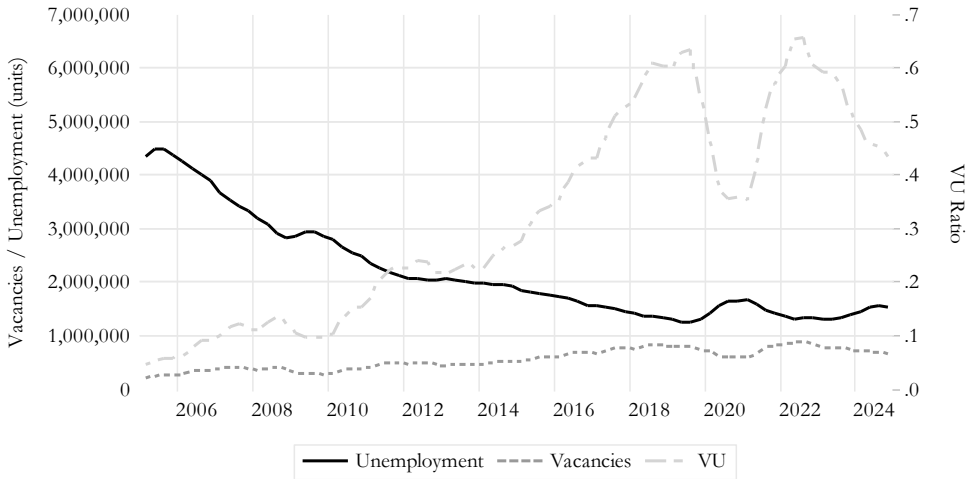
In Figure 1 we display the V-U datapoints and the estimated Beveridge curves for the two subperiods identified by the structural break tests in the case of Germany, while in Figure 2 we present the time series of the labour market variables.[42] The figures show that the steepening of the Beveridge curve after 2009Q1 is associated with lower unemployment rates and higher vacancy rates, *i.e.* an inward shift of the Beveridge curve, indicative of an increased efficiency of the labour market and thus confirming that the break is related to the Hartz reforms: firms have stronger incentives to open job vacancies and matching between workers and jobs is more efficient.

Figure 1 - German Beveridge curve



[42] Figure 1 is an interesting example of the possible observational equivalence between a nonlinear curve and a structural break in linear curves, mentioned in Section 3.1.1: our two-segment linear model produces a pattern that closely resembles a single nonlinear (convex) Beveridge curve.

Figure 2 - Evolution of the German labour market



We now turn to the case of the euro area, described in Figures 3 and 4, for which we identified four distinct periods: 2006:1-2010:4, 2011:1-2017:1, 2017:2-2021:3, and 2021:4-2024:4.

Under our specification, during the first two periods, the Beveridge curve shifted outward. This result is consistent with evidence reported by Consolo and Da Silva (2019) and Bonthuis et al. (2016) of a post-GFC outward shift. This outward movement likely reflects the deterioration in aggregate labour market efficiency that followed the Global Financial Crisis and the subsequent Sovereign Debt Crisis. However, unlike the aforementioned authors, we find that the monetary union's Beveridge curve shifts do not end here.

Figure 3 shows that the EA Beveridge curve progressively steepened and shifted inwards (with lower unemployment rates and higher vacancy rates) between 2017 and 2021, indicating that the vacancy rate became more responsive to the unemployment rate. Unsurprisingly, developments in Germany's labour market have likely influenced these shifts, given the country's economic scale and its pivotal role within the euro area. Nonetheless, the aggregate Beveridge curve surely reflects broader changes across the member states of the monetary union. For instance, Consolo and Da Silva (2019) find that the Beveridge curves for Italy and France, two other major euro area economies, also steepened in the post-2016 period. At the same time, Consolo and Da Silva (2019) note that cross-country matching efficiency began to recover after 2014, which can likely be attributed to the post-Sovereign Debt Crisis recovery. Figure 4 further informs that while unemployment started to decrease and vacancies started to recover around 2014, when the Sovereign Debt Crisis was largely

surpassed, the level of vacancies only became above the historical average since around 2017 – which may explain the detection of the break at that time and not in 2014.

Our results for 2021:4-2024:4 confirm the progressive inward shift and steepening of the EA Beveridge curve (with the estimate of a positive slope not statistically significant and the data points clearly suggesting a markedly steep curve).

Figure 3 - Euro area Beveridge Curve

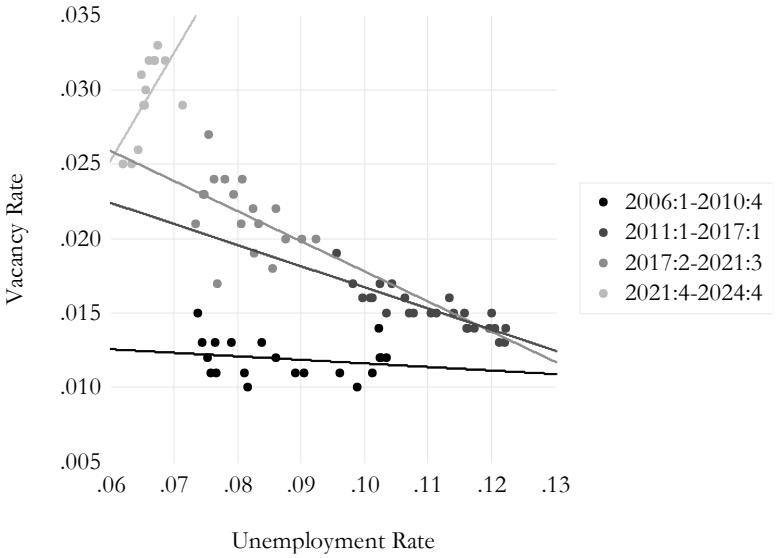


Figure 4 – Evolution of the euro area labour market

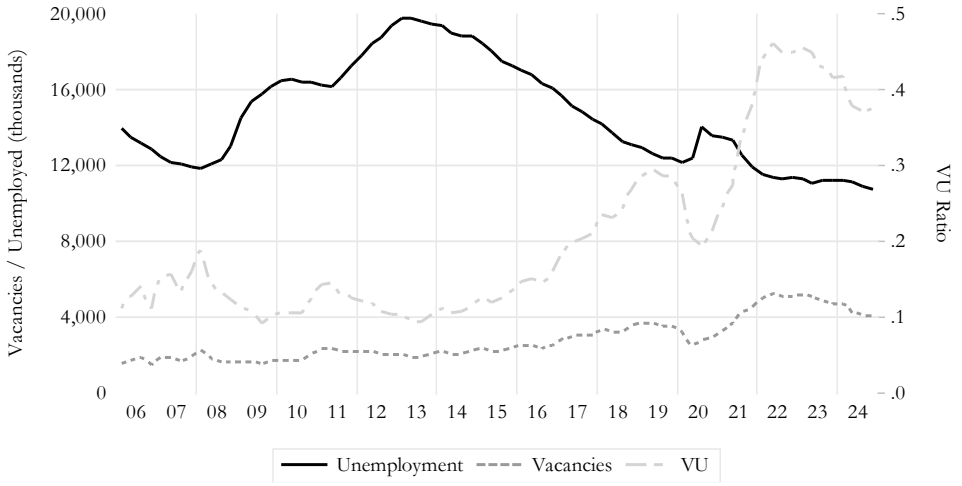
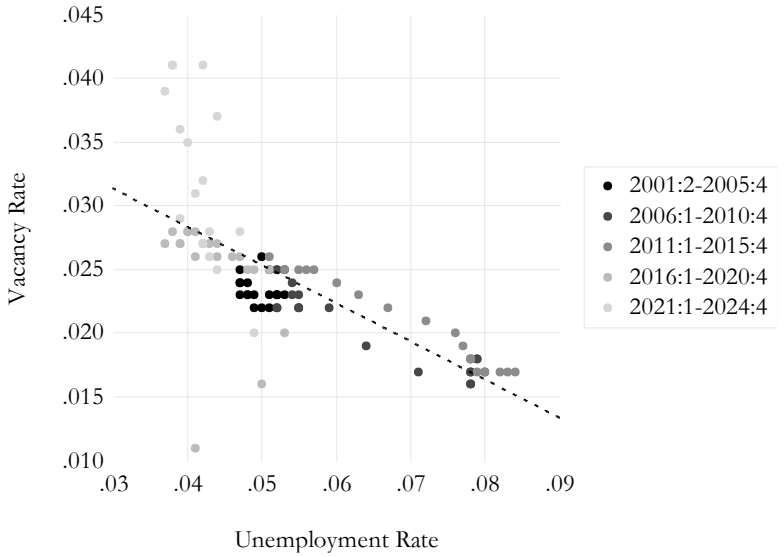


Figure 5 shows the Beveridge curve estimates and Figure 6 shows the time series of interest in the case of the UK. Statistically, we found no structural breaks in the UK's Beveridge curve, suggesting no substantial changes in the sensitivity of the vacancy rate to the unemployment rate. Figure 5 shows that the data are indeed consistent with a stable Beveridge curve but indicate movements along the unique curve. First, in 2006:1-2010:4 and

in 2011:1-2015:4, the unemployment rate increased, and the vacancy rate decreased, surely as a result of the Great Recession. Then, in 2016:1-2020:4, the unemployment rate decreased and the vacancy rate increased, as the economy recovered from the GR – a result also noticed by Casey and Mayhew (2024).

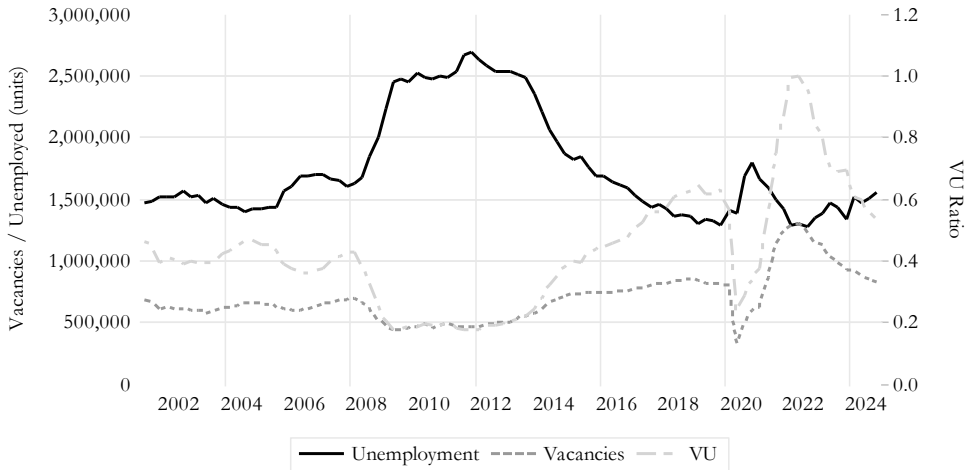
In 2021:1-2024:4, the unemployment rate was broadly constant at 4% and the vacancy rate increased. While similar to the developments noted above for the euro area, such outcomes also roughly coincide with the implementation of Brexit at the beginning of 2021. Casey and Mayhew (2024) suggest that Brexit led UK firms to behave in a peculiar manner: aware of the loss of a source of labour and expecting a medium-to-long-term improvement of the economic situation, UK employers advertised jobs whilst knowing that many would not be filled, in the hopes of capturing additional employees. Subsequently, once the labour market settled, they could reduce their job postings. From the observation of vacancies and the VU ratio in Figure 6, it seems to be exactly what happened.

Figure 5 - United Kingdom Beveridge curve[43]



[43] Unlike previous Beveridge curve charts, the chosen divisions of the UK Beveridge curve are arbitrary and do not correspond to sub-periods determined by the Bai-Perron tests, serving only to help illustrate the evolution of the combinations of (v,u) throughout the period.

Figure 6 – Evolution of the UK labour market



Figures 7 and 8 present our analysis of the US Beveridge curve.

At first sight, the evolution of the US Beveridge curve throughout 2001:1-2024:4 contrasts with the patterns seen in the other regions, as it has not steepened and indeed shows statistical signs of having flattened. However, the statistical results may not have a comparable economic relevance.

Prior to the Global Financial Crisis, the US Beveridge curve was relatively steep (slope of about -0.44), but since the GFC, in 2009:2-2020:2, it has undergone a noticeable flattening (to a slope of around -0.30), with higher vacancy rates and a larger variation in the unemployment rate. This post-GFC outward shift aligns with the findings of Kindberg-Hanlon and Girard (2024) and Barlevy et al. (2024), and is likely tied to the deterioration of matching, and search effectiveness verified in the aftermath of the Great Recession (Barlevy et al., 2024; Barnichon & Figura, 2015; Elsby et al., 2010). A marked outward shift of the US Beveridge curve can be observed during the onset of the pandemic in March 2020, when a "record number of layoffs resulted in an unprecedented spike in unemployment inflows" (Barlevy et al., 2024, p. 94). Given the uncertainty surrounding the duration of the lockdowns, many employees were temporarily laid off, with the expectation that they would be re-hired once conditions stabilised. This led to an abrupt increase in the unemployment rate – reaching a post-Second World War record high – and a negligible drop in the vacancy rate (Barlevy et al., 2024). After the early stages of the pandemic, employees started being recalled, which led to a fall in the unemployment rate, partially correcting the earlier rightward shift of the Beveridge curve.

The figures show that in 2009:2-2020:2 the US vacancy rate was increasingly less sensitive

to the unemployment rate than in 2001:1-2009:1. Several factors may explain this change. In the aftermath of the Great Recession, a large increase in skill mismatch – defined as the "misalignment between the skills or locations of unemployed workers and available job openings" (Barlevy et al., 2024, p. 93) – was noticed (Barlevy et al., 2024; Elsby et al., 2015; Şahin et al., 2014). This mismatch may have contributed to a substantial number of jobs remaining vacant even during high unemployment, leading to a flatter Beveridge curve. A further contributing factor may be the decline in labour force participation, particularly in the post-pandemic period.

The flattening estimated for 2020:3-2024:4, in contrast, seems to be essentially driven by some quarters with increasing unemployment and no substantial changes in the vacancy rate. Overall, excluding those quarters, the period is better characterised by an increase in the vacancy rate and no substantial change in the unemployment rate. In fact, in 2021, the United States experienced a sharp increase in the quits rate, as many workers reassessed their work-life balance and career paths. This became known as the Great Resignation (Barlevy et al., 2024). This phenomenon saw a large share of employed individuals actively seeking new employment, which may have had an unusual impact on the Beveridge curve. On the one hand, an increase in job-to-job transitions incentivised firms to post more vacancies (Barlevy et al., 2024; Elsby et al., 2015). On the other hand, unemployment remained somewhat unchanged, as these job-to-job flows bypassed the unemployment pool (Elsby et al., 2015). Taken together, the simultaneous rise in the job vacancy rate and the relative stability of the unemployment rate would actually point to a steepening of the Beveridge curve, in line with what happened in the other regions.

Figure 7 - US Beveridge Curve

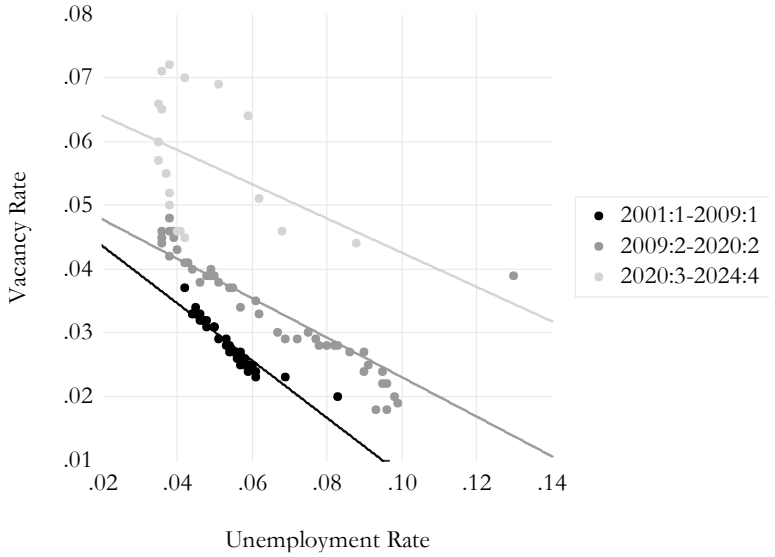
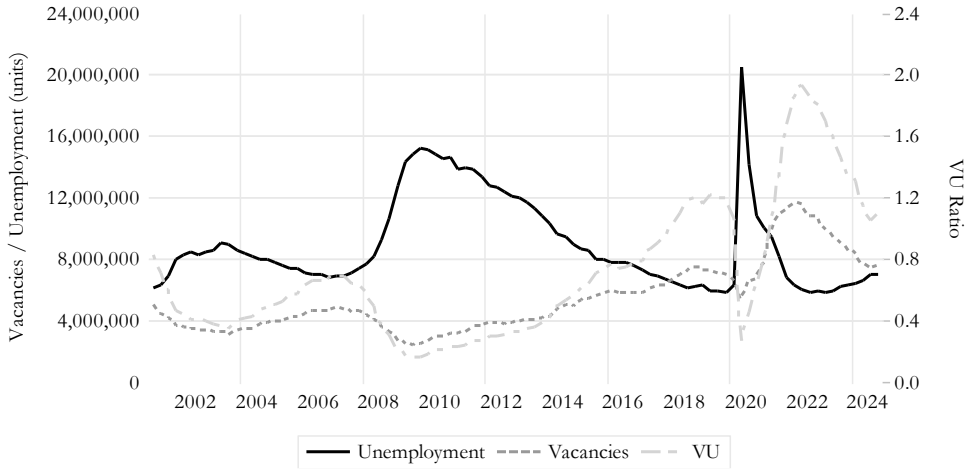


Figure 8 - Evolution of the US labour market



4.3.2. Standard Phillips curves

We now turn to the subsample estimates of the standard (unemployment rate) Phillips curve. We estimate a remarkably stable relationship in all regions during the full sample, with either no structural breaks (Germany, EA) or a single break (UK, US). Results are summarised in Table 11.

As discussed in Section 4.2, the absence of breaks in Germany and the euro area aligns with the findings of Hindrayanto et al. (2019). These authors examined the Phillips curve for the euro area and its five largest member states – which includes Germany – and concluded that the relationship between inflation and their preferred measure of economic slack, the unemployment gap, did not exhibit any significant shifts in the aftermath of the

Great Recession.

For both the UK and US, we estimate statistically significant Phillips trade-offs with coefficients in line with the literature and stable over most of the sample period, *i.e.,* 2001-2021. For the subsequent period, 2021:3-2024:4, our estimates of the Phillips curve slope are not statistically significant. Therefore, our results do not point to the hypothesis of a post-pandemic steepening of the Phillips curve, as proposed by Hobijn et al. (2023).

Table 11 - Standard (U) Phillips curve subsample estimates

Dependent Variable (π)	$\pi = k + \alpha*u + \beta*E(\pi) + \gamma*SS$					
	Break Date	**Period**	**k**	**α**	**β**	**γ**
GER	No breaks					
EZ	No breaks					
UK	2021:3	2001:2-2021:3 2021:4-2024:4	-0.0181***	-0.2812*** 0.0064	1.6703***	0.0971***
USA	2021:3	2001:1-2021:3 2021:4-2024:4	0.0011	-0.2596*** -0.0301	1.1593***	0.0637***

Notes: *, **, and *** denote significance at the 10, 5 and 1 percent level, respectively. Standard errors are computed using the Newey and West (1987) HAC estimator of the covariance matrix. The number of breaks and corresponding breaks are chosen based on the ℓ vs. $\ell + 1$ breaks test proposed by Bai and Perron (1998, 2003). The trimming parameter is set to 15%.

4.3.3. *Phillips-meets-Beveridge* Phillips curves

Finally, we turn to our results for the *Phillips-meets-Beveridge* (VU-driven) Phillips curve. Results are presented in Table 12.

As mentioned above, the VU Phillips curve appears to be less stable than the U Phillips curve in all regions, except for the UK, in which the structural break is identified precisely in the same quarter.

In all regions and subsamples, we find positive and statistically significant estimates for the slope of the VU Phillips curve. We notice an overall tendency for the VU Phillips curves to steepen after 2021 – except for the US – indicating that inflation has become more responsive to labour market tightness as measured by the VU ratio after the COVID pandemic. During this time (2021:4-2024:4), as shown in Figure 9, all regions registered a strong decrease in their respective VU ratios, after the marked increase in 2020-21, indicating a turn from tighter to looser labour markets after COVID. Figures 10 and 11 illustrate, for

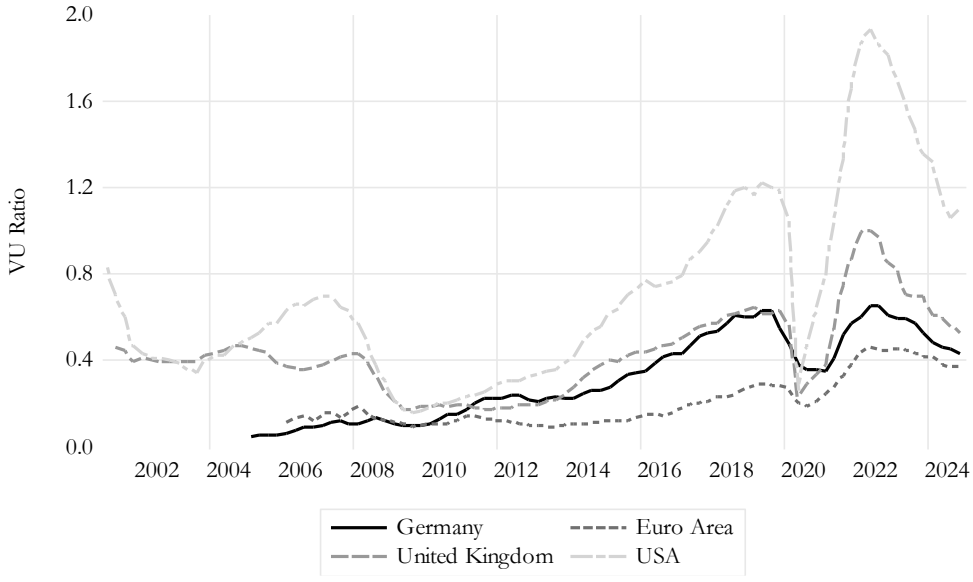
the cases of Germany and the US, how the VU ratio and inflation were strongly associated since the COVID-19 pandemic – firstly increasing, in 2020-21, and then both decreasing in tandem in 2022-24. One may conclude that the steepening of the curve had already started in the last quarters of the previous subsample period, during COVID times.

Table 12 - Phillips-meets-Beveridge (VU) Phillips curve subsample estimates

Dependent Variable (π)	$\pi = k + \varphi*VU + \beta*E(\pi) + \gamma*SS$					
	Break Date	**Period**	**k**	**φ**	**β**	**γ**
GER	2016:2	2005:1-2016:2		0.0381***		
	2021:3	2016:3-2021:3	-0.0112**	0.0203***	0.9123***	0.1509***
		2021:4-2024:4		0.0405***		
EZ	2022:2	2006:1-2022:2	-0.0106**	0.0397***	0.9054***	0.1453***
		2022:3-2024:4		0.0683***		
UK	2021:3	2001:2-2021:3	-0.0418***	0.0253***	1.5467***	0.0855***
		2021:4-2024:4		0.0380***		
USA	2013:2	2001:1-2013:2		0.0195***		
	2021:3	2013:3-2021:3	-0.0111*	0.0097***	0.7318***	0.0736***
		2021:4-2024:4		0.0182***		

Notes: *, **, and *** denote significance at the 10, 5 and 1 percent level, respectively. Standard errors are computed using the Newey and West (1987) HAC estimator of the covariance matrix. The number of breaks and corresponding breaks are chosen based on the ℓ vs. $\ell + 1$ breaks test proposed by Bai and Perron (1998, 2003). The trimming parameter is set to 15%.

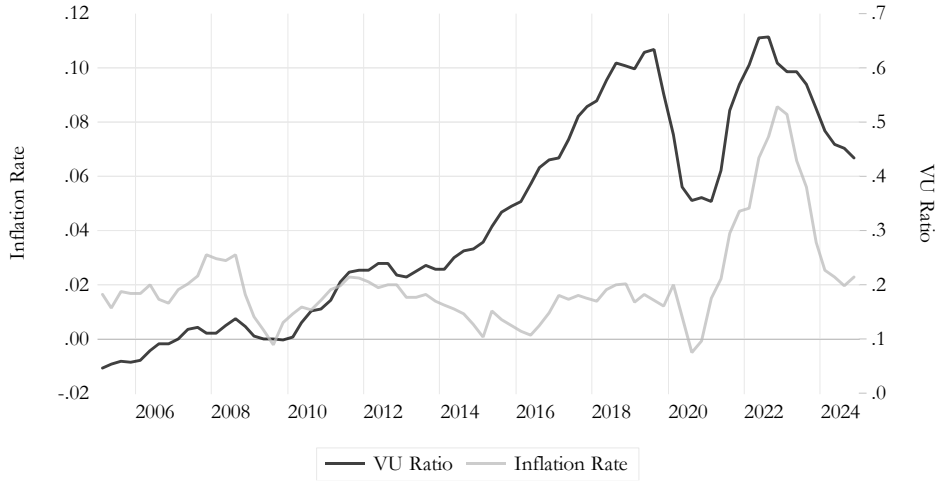
Figure 9 - VU ratios for Germany, euro area, UK and US



The steepening of the VU Phillips curve in Germany, the euro area, and the UK has had a uniform pattern. While in the euro area and the UK we estimate a steepening at the end of 2021, following a stable curve since the early 2000s, in Germany we estimate that the slope declined in 2016:3-2021:3, indicating a temporary weakening in the sensitivity of inflation to the vacancy-to-unemployment ratio. As shown in Figure 10, during that period, despite a steady rise in the VU ratio, inflation remained relatively stable around the ECB's 2% target. This pattern may be partly attributed to the Hartz reforms, which increased employment (Burda & Seele, 2020) but also contributed to wage polarisation, particularly at the lower end of the income distribution (Dustmann et al., 2014). As a result, the post-GFC recovery saw improving labour market conditions without corresponding wage or price pressures, due to subdued wage growth feeding into lower unit labour cost growth and, in turn, muted inflation.

With the start of the post-COVID recovery, the link between inflation and the labour market visibly strengthened, as described above, mirroring the results for the euro area and the UK.

Figure 10 - Inflation and VU in Germany

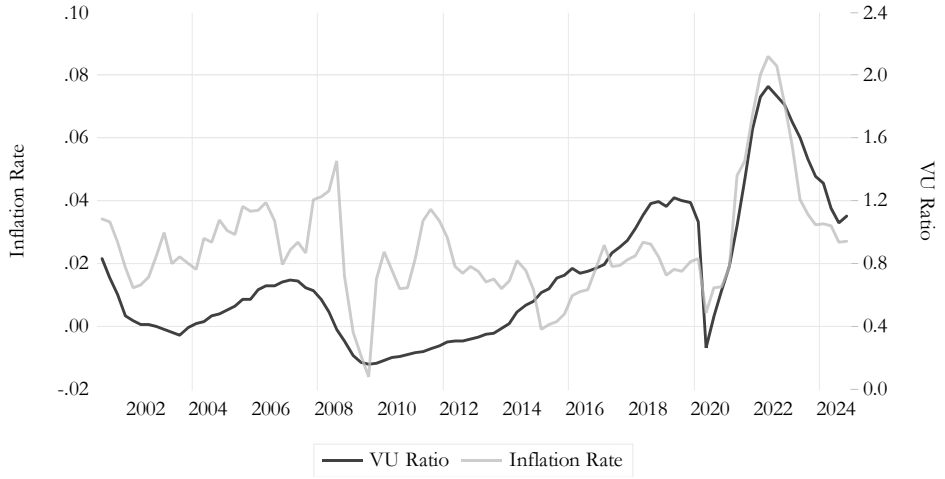


As discussed above, we do not estimate any steepening of the US *Phillips-meets-Beveridge* Phillips curve, as the estimate for the slope is similar for 2001:1-2013:2 and 2021:4-2024:4. Yet, we find that between 2013:3 and 2021:3 the relationship between inflation and labour market tightness (measured by the VU ratio) was markedly weaker than before 2013 and after 2021. Figure 11 clearly shows why: while the VU ratio steadily increased up until the pandemic, inflation kept fluctuating around the FED's 2% target (albeit with strong volatility in 2014-16). Increases in the VU ratio are likely related to the policy response following the

2008 financial crisis, which focused on reducing unemployment through measures such as the Recovery Act or the HIRE Act (Farooq & Kugler, 2015). At the same time, the US underwent the "missing inflation" phenomenon. Recall that a similar pattern is observed for the standard Phillips curve: during this period, despite the steady fall in unemployment (Figure 8), inflation remained relatively subdued.

Figure 11 clearly shows that inflation and the VU ratio were strongly associated in 2020-21 (both rising) and in 2022-24 (both falling), as seen in the case of Germany – even though the degree of association turns out not to be statistically higher than the one estimated for 2001-13, in the case of the US, as shown in Table 12.

Figure 11 - Inflation and VU in the US



As mentioned above, in both the case of the euro area and the UK, we estimate only one structural break and the steepening of the VU Phillips curve at mid-2022 and the end of 2021, respectively. As in the previously analysed regions, this steepening is likely associated with the specific conditions of the COVID-19 recession and the post-COVID recovery. In particular, across all areas, the recovery period is marked by falling unemployment and rising vacancies, reflecting the end of the lockdowns and return of the economy to more normal functioning. This was accompanied by increasing inflation, driven by several factors, such as rising commodity prices, and internal and external supply-side pressures stemming from supply chain-related price shocks (de Soyres et al., 2024; Hohberger, 2025; Topalova et al., 2023), as well as demand reallocation shocks due to a shift in consumption from services to goods (Ferrante et al., 2023). Together, this led to a sharper increase in the VU ratio and, crucially, to a stronger pass-through from labour market tightness to inflation. The observed steepening of the VU Phillips curve thus reflects a heightened sensitivity of inflation to

changes in the VU ratio.

We finalise by presenting Table 13, which shows the SSR of both models for the four regions. The SSR in this table correspond to the sum of the subsamples' SSR, for both the U and VU specifications of the Phillips curve (in the case of Germany and the euro area, as we detected no break in the standard Phillips curve, the respective SSR are the same of Table 8). The results are overall even stronger than for the no-break full sample estimations, reported in Table 8. Allowing for structural breaks, the *Phillips-meets-Beveridge* Phillips curve improves the SSR by 20.8% and by 32.8% in the cases of Germany and the euro area (against +3.2% and -19.8% in the full sample regression comparisons of Table 8). In the case of the US, the improvement of the fit is even starker: the SSR fall to almost half of what they are with the standard Phillips curve with breaks. The UK case has less clear-cut but even so favourable results: while the SSR fall by 21.5% under no breaks, they fall by 10.9% when structural breaks are allowed for in both the standard and the VU Phillips curve. Overall, we conclude that the *Phillips-meets-Beveridge* curve has a better performance when modelling inflation than the standard Phillips curve.

Table 13 - Sum of squared residuals for the standard and Phillips-meets-Beveridge (sum of subsamples)

Country	SSR		Relative Change
	Standard (U)	Phillips-meets-Beveridge (VU)	
GER	0.0048	0.0038	-20.8%
EA	0.0061	0.0041	-32.8%
UK	0.0047	0.0042	-10.9%
USA	0.0032	0.0016	-48.9%

4.4. Discussion

In this section, we provide a brief overall discussion of our main results in the light of economic events and scientific literature.

The Bai-Perron tests for structural stability provided clear statistical evidence of structural breaks in the linear Beveridge curves that coincide with major macroeconomic shocks, notably the Global Financial Crisis, the Eurozone Sovereign Debt Crisis, and the COVID-19 pandemic. Interestingly, while breakpoints are generally aligned across countries during global crises, we also find evidence of some idiosyncratic structural changes. The German Beveridge curve, for example, exhibits fewer and more muted shifts compared to the euro area (and the US), which seem to reflect the delayed effects of earlier labour market

reforms.

Our estimates of the Beveridge curves confirmed a robust and statistically significant negative relationship between the unemployment rate and the vacancy rate, consistent with the theoretical framework proposed by Dow and Dicks-Mireaux (1958). However, we find a significant variation in the steepness of the Beveridge curve across regions.

The United States exhibits the steepest curve, a result consistent with its highly dynamic labour market (Nickell, 1997). This happens despite the US having undergone a substantial flattening process. On the one hand, this phenomenon is likely related to a deterioration of both matching and search effectiveness following the Global Financial Crisis (Barlevy et al., 2024; Barnichon & Figura, 2015; Elsby et al., 2010). On the other hand, increasing unemployment without an expected accompanying drop in the vacancy rate during the start of the pandemic, compounded by the effects of the Great Resignation (Barlevy et al., 2024), further contributed to the more recent flattening of the US Beveridge curve.

The UK displays a stable Beveridge curve and has the second largest slope, likely due to its more flexible employment institutions within the European context (Nickell, 1997).

Germany's Beveridge curve underwent a remarkable steepening process, inseparable from the early 2000s Hartz labour market reforms, which intended to make the German labour market more flexible (Pissarides, 2013). The reforms resulted in higher job matching efficiency, a durable increase in labour force participation, and a reduction in unemployment (Burda & Seele, 2020). Despite their implementation in the early 2000s, it is likely that their results were lagging (Bonthuis et al., 2016), leading to the later shift of the Beveridge curve that we find in 2009. Given Germany's weight within the euro area, it is likely that changes in its labour market had a deep impact on aggregate euro area labour market dynamics.

The euro area Beveridge curve shifted outwards following the Great Financial Crisis – a consequence of deteriorating labour market efficiency (Bonthuis et al., 2016; Consolo & Da Silva, 2019). However, from 2017:2 onwards, it has progressively steepened and shifted inwards. This seems to be the result not only of the changes noted in Germany, but also of the steepening of the Beveridge curve in other major euro area economies, such as France and Italy, during the recovery period (Consolo & Da Silva, 2019).

It is important to note that the Beveridge curves in our work are constrained to be linear, therefore possibly not capturing the full complexity of labour market dynamics if the true underlying relationship is nonlinear. However, by allowing for multiple structural breaks, our model can approximate a nonlinear functional form through a series of connected linear

segments. In this sense, our approach is observationally equivalent to a smooth, but nonlinear Beveridge curve. The German Beveridge curve (Figure 1) is a clear example of this equivalence: we find two different regimes, and that the linear specifications of both our subsamples are observationally equivalent to a single convex specification.

Regarding the standard (U) Phillips curve, we estimate remarkably stable relationships in all regions during the full sample. Although no structural breaks are detected in Germany and the euro area – consistent with Hindrayanto et al. (2019) – we find breaks for the UK and US. Some interesting similarities can be observed for these latter areas: both have one coinciding break in the final quarter of 2021, both register statistically significant slope coefficients in the first period, which are in line with the literature, and subsequent period estimates are not statistically significant. Our results lead us to favour the hypothesis of a continued flattening of the Phillips curve (following, e.g., Galí and Gambetti (2019)) with no post-pandemic steepening (proposed by Hobijn et al. (2023)).

Our results for the *Phillips-meets-Beveridge* (VU) Phillips curve differ greatly from the standard Phillips curve results. We find the VU Phillips curves to be more unstable than the standard curve for most regions – the UK being the sole exception, with a single break that coincided with the one found in our standard Phillips curve. For all regions and subsamples we obtain positive and statistically significant estimates of the Phillips curve slope. Overall, there seems to be a tendency for the *Phillips-meets-Beveridge* Phillips curve to steepen after 2021 (except in the US). This is the result of the particular conditions of the COVID-19 recession and subsequent recovery. During the recovery, the VU ratio of all areas registered a stark increase, because of falling unemployment and rising vacancies, a consequence of the end of the lockdowns and return to a more normal functioning economy. This period also saw a rise in inflation, as a result of a multitude of factors (e.g., rising commodity prices, supply chain-related price shocks and demand reallocation shocks (Ferrante et al., 2023)).

For the euro area and UK curves, we estimate a single structural break (in 2022:2 for the EA and 2021:3 for the UK) and find evidence of steepening, linked to the factors we mentioned above.

In Germany, the slope of the VU Phillips curve declined in 2016:3–2021:3. It is likely that the Hartz reforms are at the centre of the weakening of the relationship between inflation and the VU ratio during this period. While they contributed to increasing German employment (Burda & Seele, 2020), they also led to increased wage polarisation, especially at the lowest levels of income distribution (Dustmann et al., 2014). As such, the combination

of improved labour market conditions and subdued wage growth (and through this, muted inflation) resulted in a weakened inflation-VU ratio relationship.

In the US, the *Phillips-meets-Beveridge* Phillips curve shows no signs of steepening, displaying similar slopes in both the first and last subsamples. Nevertheless, in between these periods (that is, during 2013:3-2021:3), much like in Germany, the relationship between inflation and labour market tightness was substantially weaker. An analysis of the evolution of inflation and the VU ratio in the US (available in Figure 11) helps explain this: during this time, the US VU ratio steadily increased, as a result of the policy response following the Global Financial Crisis that focused on reducing unemployment (Farooq & Kugler, 2015); at the same time, US inflation was fluctuating around the FED's 2% target. The outcome was like Germany's: a continuous improvement in labour market conditions without an accompanying increase in the inflation rate, leading to a disconnect between inflation and the VU ratio.

One of the main objectives of this dissertation was to assess if the claim of Barnichon and Shapiro (2024) that the VU Phillips curve is more informative than traditional specifications holds, particularly outside of the US. The answer is yes. We found that, for the full sample estimations, the *Phillips-meets-Beveridge* Phillips curve performs much better than the standard specification (or at least similarly, as is the case of Germany). We found a much lower sum of squared residuals in the *Phillips-meets-Beveridge* Phillips curves, even more so when we allow for breaks and subsample estimates of the slope.

While the results of this dissertation are consistent with and expand upon the conclusions of Barnichon and Shapiro (2024) for the US, we contribute to the literature by demonstrating that also in the cases of Germany, the euro area, and the UK, a combination of the Phillips and the Beveridge curves markedly improves the explanation of inflation dynamics. The *Phillips-meets-Beveridge* specification not only yields statistically stronger relationships, but also better reflects the economic realities of recent crises and recoveries. In other words, Phillips should meet Beveridge in the US, Germany, the euro area, and the UK.

5. Conclusion

In this dissertation we studied the Beveridge and the Phillips curves of Germany, the euro area, the UK, and the US, with samples starting at the beginning of the 2000s.

Our objective was twofold. First, we aimed at assessing the stability of linear specifications of the Beveridge and Phillips curves, focusing on their slopes. Second, following recent literature (e.g., Ball et al. (2022); Barnichon and Shapiro (2022, 2024)), we aimed at assessing whether the vacancy-unemployment ratio (VU) improves the modelling of inflation dynamics compared to the unemployment rate (U) – *i.e.* whether a *Phillips-meets-Beveridge* Phillips curve is superior to the standard Phillips curve.

To do so, we used quarterly time series from official statistical sources and least squares to estimate standard specifications of the Beveridge curve and two specifications of a Phillips curve with elements of the New Keynesian Phillips Curve and Gordon's Triangle Model: one using the unemployment rate, the other using the VU ratio as driving variable for consumer price inflation. We proceeded in three steps. First, we estimated the three curves over the full samples. Second, we assessed their stability with the Bai and Perron (1998, 2003) structural stability tests. Third, we estimated the three curves in the subsamples identified in step two, allowing the slope coefficients to vary across regimes, while restricting all others to their full sample estimates.

Our main findings may be summarised as follows.

The Beveridge curve was significant in all regions. While it was steep and stable in the UK, it had structural breaks in its slope in Germany and the euro area, where it steepened after the Global Financial Crisis, and in the US, where it somewhat flattened. Especially in the case of Germany, the linear specifications of the two subsamples would be observationally equivalent to a single convex specification.

The standard (U) Phillips curve was highly significant in Germany and the US, but somewhat less so in the aggregate euro area and the UK. Its slope was statistically stable in Germany and the euro area, changing only at the end of the sample, after COVID, in the UK and the US, when it became insignificant. We are thus unable to confirm the flattening of the Phillips curve observed by many authors (e.g., Ball and Mazumder (2011); Blanchard (2016); Coibion and Gorodnichenko (2015); Del Negro et al. (2020)).

The *Phillips-meets-Beveridge* (VU) Phillips curve was highly significant in all four regions, but less stable than the standard Phillips curve, except in the case of the UK, in which both curves' structural breaks coincide in timing. According to our estimates, its slope increased

markedly since the end of 2021 (Germany, UK) or mid-2022 (euro area), while it remained stable (and smaller) in the US.

Notably, the VU Phillips curve performs much better than the standard (U) Phillips curve in modelling inflation dynamics, with the only exception of Germany, where both perform similarly. This result is consistent with Barnichon and Shapiro (2024) and suggests that the VU ratio captures changes in labour market tightness and inflationary pressure as well or more effectively than the unemployment rate. The bottom line is that we find compelling evidence that Phillips should meet Beveridge not only in the US (as established in the literature) but also in the UK, the euro area and even Germany.

Our study is not without limitations. One major limitation is the availability and quality of vacancy data, especially in the European regions. While the US has a long data series, which even allows for studies with monthly data, vacancy series for the European regions are still very limited, leading us to resort to approximations.

Regarding the breaks, while the Bai–Perron procedure offers a formal and transparent method to detect multiple discrete structural breaks, we cannot ignore the possibility of parameter changes being a gradual process. Moreover, we cannot discard the possibility of there being nonlinearities, especially in the Beveridge curve models, which we are unable to study via our chosen linear specification. The observational equivalence between a nonlinear specification and piecewise subsample linear specifications is well-known and is arguably a limitation of this dissertation.

Future research could attempt to address these challenges in several ways. Tackling the data limitations seems to be the hardest challenge, as only time will be able to provide higher-quality data on vacancies for Europe, and through it, better and more informative results. Future studies may explore nonlinearities in the relationships by testing for nonlinear models of the Beveridge and Phillips curves against their linear counterparts and, if nonlinearities are statistically detected, opt for nonlinear specifications rather than linear subsample specifications. To tackle the possibility of non-discrete structural breaks, future research could model potential parameter changes as a gradual process. A state-space representation of the Beveridge and Phillips curves, estimated via a Kalman filter, for example, could allow the slope coefficients to vary smoothly over time rather than shifting abruptly. This time-varying parameter approach could capture evolving relationships that are not well approximated by piecewise-constant regimes, particularly during periods of persistent but gradual structural change. However, both econometric refinements – tests of nonlinearity

and time-varying parameter models – are beyond the scope of this dissertation.

Our findings carry potential implications for policymakers, particularly central banks. Our results suggest that central banks should consider placing greater emphasis on the vacancy-to-unemployment ratio when assessing labour market tightness, as it offers a more accurate signal of inflationary pressures. Although data availability currently limits its use, the VU ratio may soon serve, at least, as a useful complement to the unemployment rate in guiding Phillips curve-based monetary policy. In sum, this dissertation adds substance to the idea put forth in very recent literature that Phillips should meet Beveridge, not only in the US but also in European regions.

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Annex

Figure A 1 - Unemployment rate

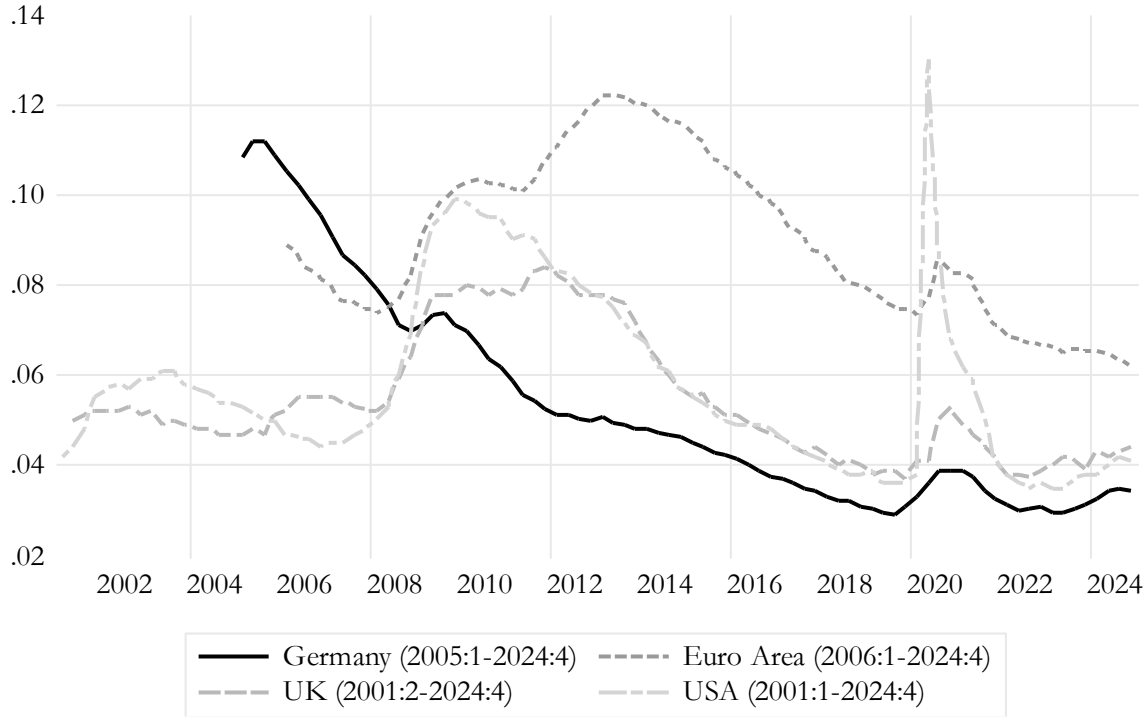


Figure A 2 - Vacancy rate

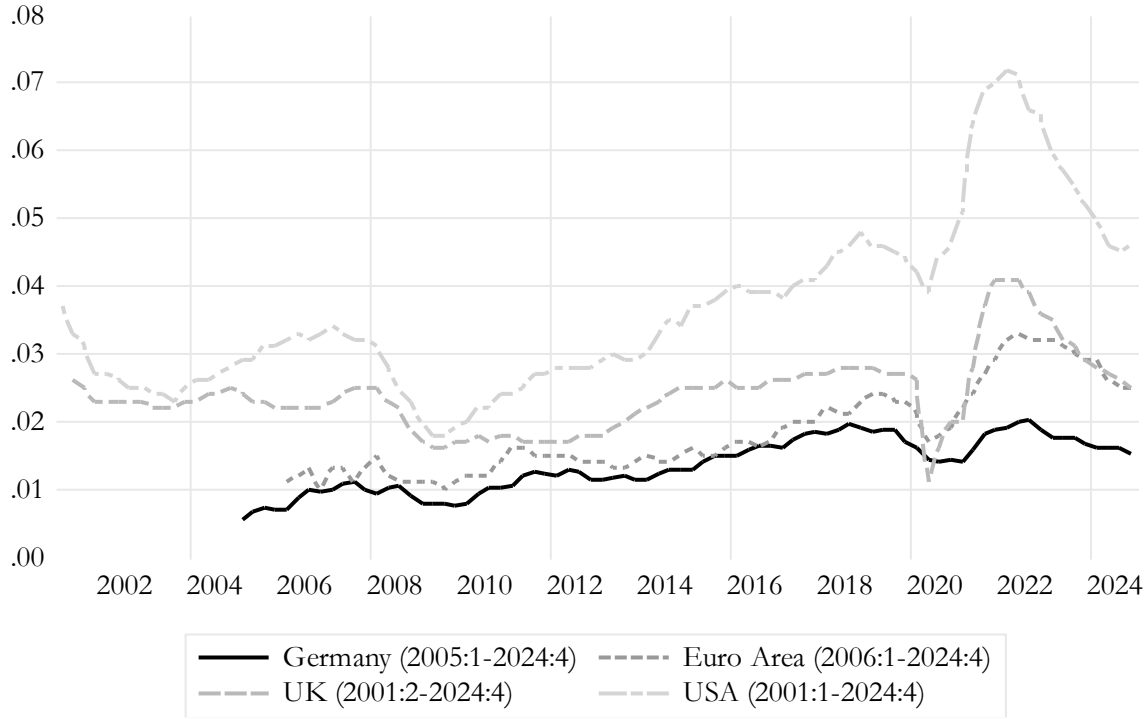


Figure A 3 - Inflation

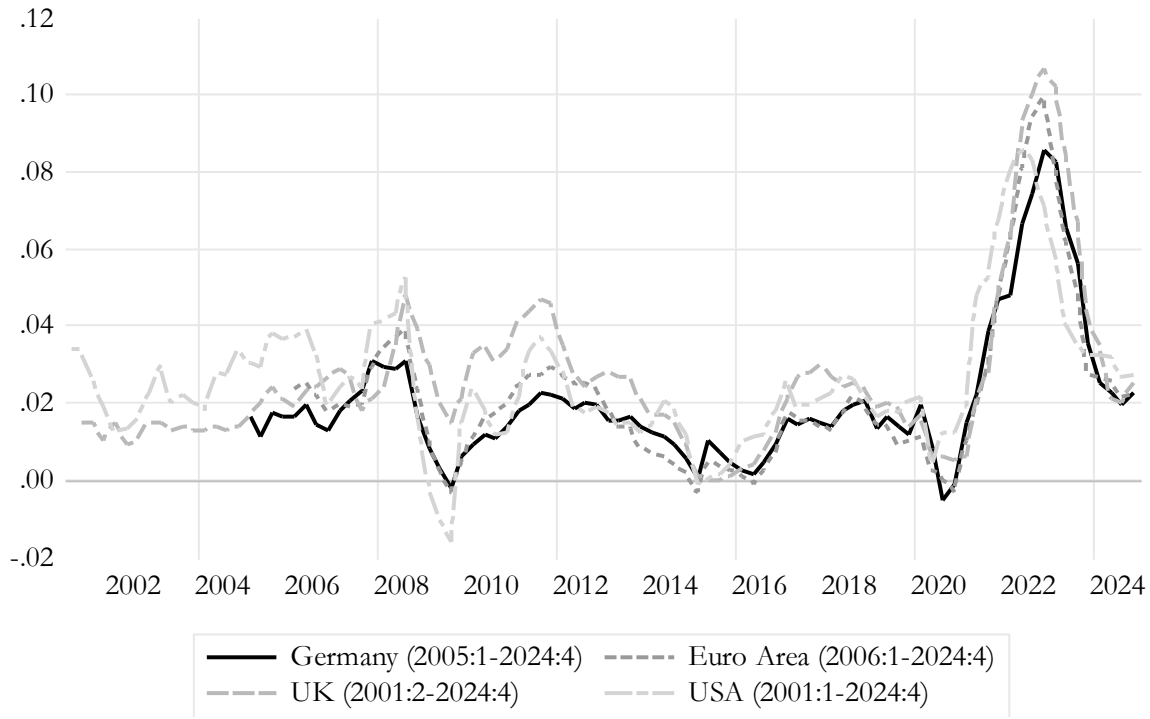


Figure A 4 - Inflation expectations

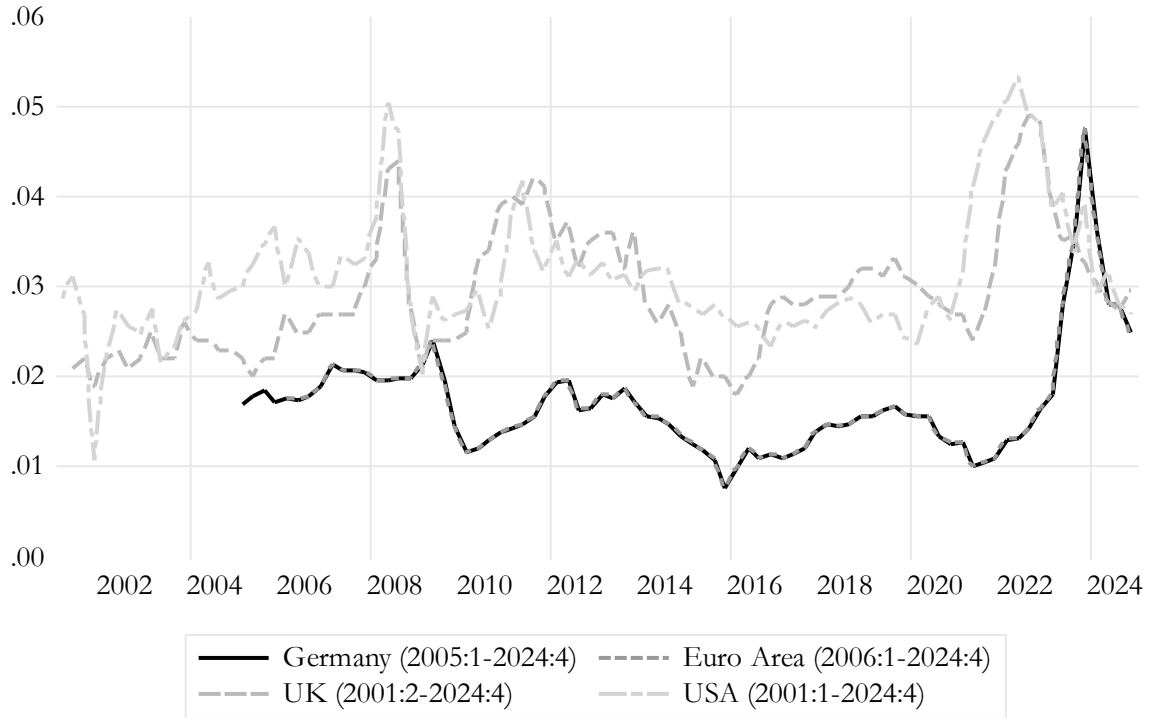


Figure A 5 - Energy inflation

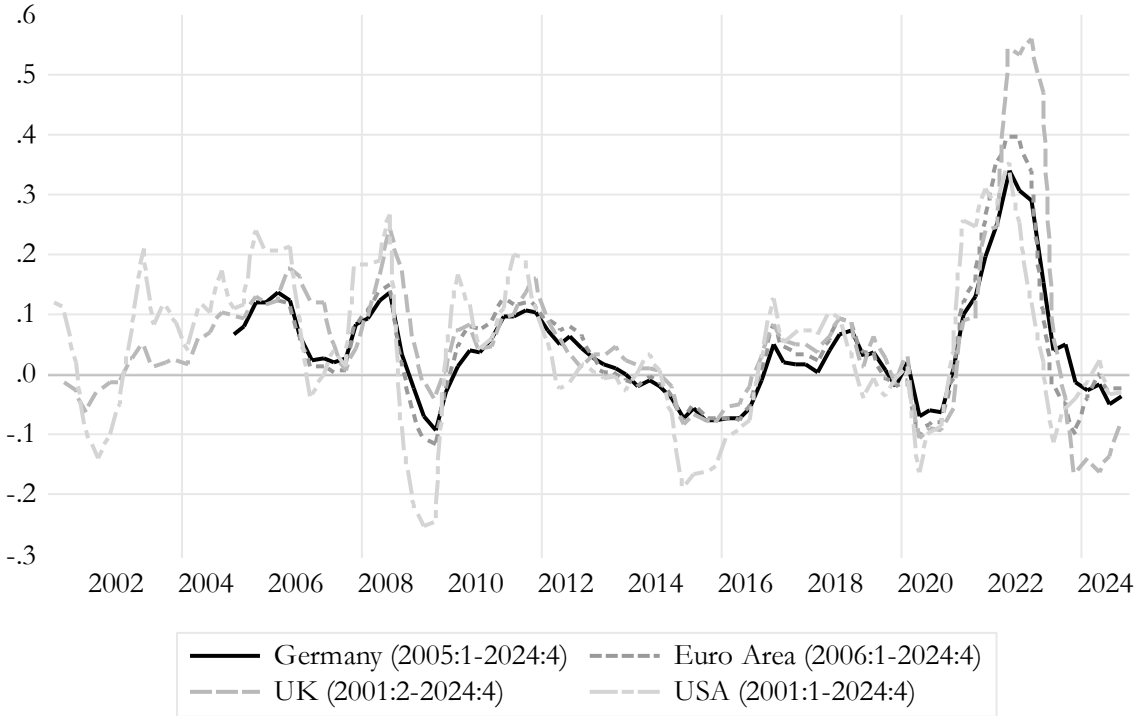
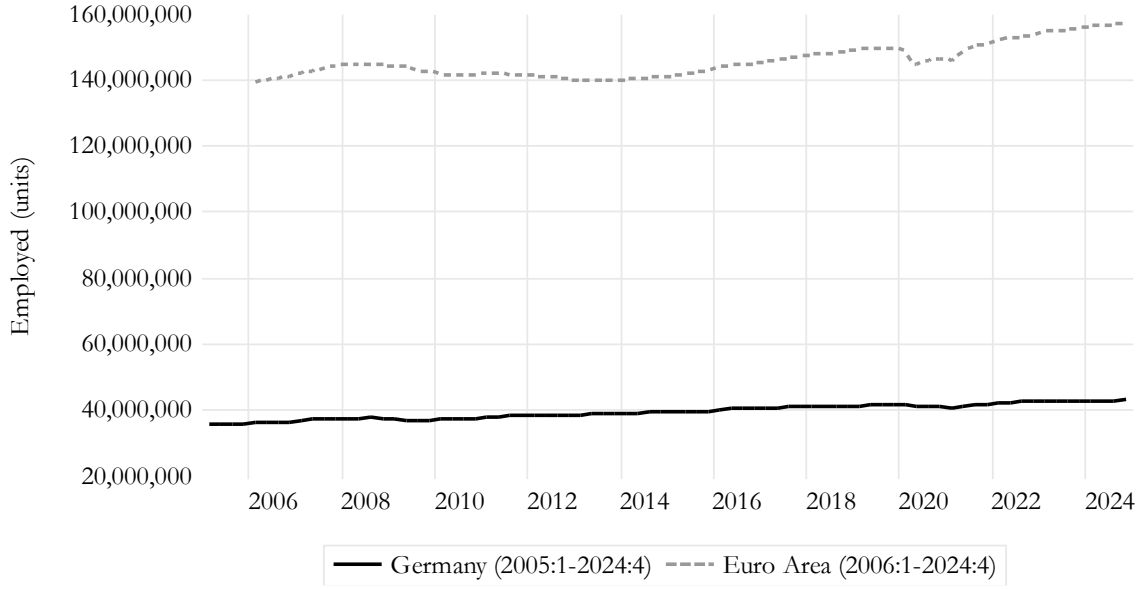


Figure A 6 - Employment



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