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Main Features of Job Matching in the EU after the Crisis**

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ABSTRACT

Is Unemployment Structural or Cyclical? Main Features of Job Matching in the EU after the Crisis*

The paper sheds light on developments in labour market matching in the EU after the crisis. First, it analyses the main features of the Beveridge curve and frictional unemployment in EU countries, with a view to isolate temporary changes in the vacancy-unemployment relationship from structural shifts affecting the efficiency of labour market matching. Second, it explores the main drivers of job matching efficiency, notably with a view to gauge whether mismatches became more serious across skills, economic sectors, or geographical locations and to explore the role of the policy setting. It emerges that labour market matching deteriorated after the crisis, but with a great deal of heterogeneity across EU countries. Divergence across countries increased. Matching deteriorated most in countries most affected by current account reversals and the debt crisis. The lengthening of unemployment spells appears to be a significant driver of matching efficiency especially after the crisis, while skill and sectoral mismatches also played a role. Active labour market policies are associated with a higher matching efficiency and some support is found to the hypothesis that more generous unemployment benefits reduce matching efficiency.

JEL Classification: J23, J24, E32

Keywords: cyclical unemployment, structural unemployment, mismatch

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1. Introduction

The 2008-2009 worldwide recession and the ensuing sovereign debt crisis have had a major impact on EU labour markets. The high and persistent unemployment rate in most EU countries has prompted concerns that the underlying structural unemployment has shifted upwards and that the increase in unemployment could persist once the recovery is on a solid footing. For some countries, the depth and the structural nature of the crisis has led many to question whether matching the pool of unemployed with new jobs has become more difficult.

Assessing whether unemployment is mostly cyclical or structural has implications for the policy response needed to address the unemployment problem. The cyclical versus structural nature of unemployment has therefore ranked high in the recent economic policy debate in the US. Despite opinions expressed both in favour of a structural (e.g., Kocherlakota, 2010) and cyclical interpretation of the increase in US unemployment (Bernanke, 2010), a consensus emerged that most of the rise in the unemployment rate after the crisis of 2008 is due to cyclical factors (e.g., Chen et al., 2011; Daly et al., 2012; Elsby et al., 2010, 2011; Dickens and Triest, 2012) or to structural mismatch of transitory nature (Daly et al., 2011; Lazear and Spletzer, 2012). A comparable debate and analysis on the nature of European unemployment has not followed yet, and analyses aimed at shedding light on the issue remain relatively scarce. In particular, while there is broad agreement that, on aggregate, structural unemployment in the EU and the euro area could have increased after the 2008 crisis in light of worsening labour market matching (e.g., Bonthuis et al., 2013, European Commission, 2013), very few analyses have focused on cross-country differences within the European Union.

For the case of the US, a number of conclusions are shared by a majority of the existing analyses on labour market mismatch after the crisis (e.g., Sahin et al., 2011; Barnichon et al., 2011; Dickens, 2011, Estevao and Tsounta, 2011; Lazear and Spletzer, 2012): (i) skill and occupation mismatch played a role in growing mismatch after the crisis; (ii) sectoral mismatch played a role, notably linked to growing mismatch in the construction sector; (iii) the role of regional mismatch was limited; (iv) the extension of unemployment benefit duration played a role; (v) the above factors played mostly a temporary role, with evidence that sectoral mismatch had returned to pre-crisis levels by 2011.

Hobijn and Sahin (2012) are among the few analyses taking a cross-country perspective, with the aim of tracking shifts in Beveridge curves over the post-crisis period in a number of

advanced countries, and identifying possible underlying causes. The present analysis takes a similar approach and aims at making a step forward in identifying Beveridge curve shifts and their determinants for EU countries.

This paper focuses on the evolution of job matching across EU countries and aims at answering a number of questions. Is there evidence that empirical Beveridge curves have shifted outward after the crisis? Have such shifts taken place across the board or are they limited to some countries only? Were these shifts only temporary or rather of a structural nature? Were they mostly linked to reduced job matching efficiency or to persistent increases in job separation rates? Finally, what were the main drivers of job matching efficiency?

The focus is on a particular source of structural Beveridge curve shifts, namely the efficiency of the matching process in the labour market as measured by job finding rates adjusted for cyclical elements, in analogy of what has been done in a number of recent papers (e.g., Barnichon and Figura, 2010). As opposed to another possible main source of Beveridge-curve shifts, namely structural changes in the job separation rate (which are mostly the outcome of country-specific interactions between economic and institutional factors), there is stronger consensus on the main drivers of matching efficiency, with a role being played by the composition of the pool of job-seekers (in particular by unemployment duration), by the degree of discrepancy (or “mismatch”) between jobs supplied and demanded in terms of skill requirement, sector, and location, and by policy (unemployment benefits, active labour market policies).

The first step in the analysis is that of tracking the relation between unemployment and vacancies, the so-called Beveridge curve, for each EU country over time. Such analysis provides key information to assess whether joblessness is mostly linked to temporary demand shifts (i.e., movements along a given Beveridge curve, with more unemployment and less vacancies open) or more to structural changes in the efficiency of the matching process of the labour market (i.e., shifts of the Beveridge curve). To this purpose, several statistical sources are used to build sufficiently long job vacancy rates time series.

Tracking the evolution of the relation between unemployment and vacancies over short time periods is not sufficient to derive conclusions on possible shifts in the Beveridge curve and in the efficiency of labour market matching. Since cyclical, demand-driven shocks also imply temporary deviations from a given Beveridge curve, a simultaneous increase in unemployment and vacancies cannot unambiguously be interpreted as an indication of

worsening labour market matching. To gain insight into possible shifts of the Beveridge curve, the subsequent step in the analysis is to estimate the deviations in the pattern of job finding rates and job separation rates, which could be linked to structural changes in labour market flows.

The cyclical adjustment of job finding and separation rates is carried out by taking into account the role of labour market tightness (i.e., the ratio between the vacancy rate and the unemployment rate) in driving labour market flows. In the case of job finding rates, such cyclical adjustment is rooted in matching models of the labour market (e.g., Pissarides, 2000), and allows to control for the fact that it is easier to find a job in good times, simply because there are more vacancies relative to the number of jobseekers.

After having analysed the pattern of changes in matching efficiency across EU countries, the subsequent step is to relate them to likely underlying causes. The focus is on mismatch along three dimensions: skill, sectors, and geography. Indicators summarising mismatch along these three dimensions are constructed and put in relation with matching efficiency, separately for each EU country in the sample.

Finally, the main drivers of matching efficiency are analysed across the available panel of countries by means of multivariate regression analysis. The role played by the composition of unemployment by duration, labour market mismatch, and policy is analysed simultaneously, in order to find out whether the main drivers of matching efficiency have changed in the post-crisis period.

The remainder of the paper is structured as follows. Section 2 introduces the conceptual framework adopted in the analysis of Beveridge curve shifts. Section 3 analyses the behaviour of the Beveridge curve across EU countries, while section 4 presents the estimation of matching efficiency and analyses Beveridge curve shifts that are likely to be of structural nature. Section 5 investigates the alternative dimensions of labour market mismatch. Section 6 analyses the main drivers of matching efficiency. Section 7 concludes and discusses implications for policy.

2. UNEMPLOYMENT DYNAMICS AND THE BEVERIDGE CURVE

The Beveridge curve, the negative relationship between unemployment and vacancies, is widely used to identify the nature of shocks that hit the labour market. Its rationalisation is derived from the requirement of unemployment stability in a matching model of the labour market (e.g., Pissarides, 2000).

At any point in time the change in unemployment equals the excess of inflows into unemployment over outflows out of unemployment. Abstracting from labour force dynamics, and normalising labour force to one,

$$\Delta u_t = s_t(1 - u_t) - f_t u_t, \quad (1)$$

where s_t is the job separation rate (inflows into unemployment) and f_t is the job-finding rate (the exit rate from unemployment). The unemployment rate is in steady state when unemployment inflows and outflows offset each other, which holds if unemployment is equal to:

$$u_t^* = s_t / (s_t + f_t). \quad (2)$$

The relation in (2) provides a foundation for the Beveridge curve (BC). The job finding rate f_t , under normal assumptions on the matching process, depends on unemployment, available vacancies and matching efficiency. Such a process is commonly modelled by a Cobb-Douglas matching function (e.g. Petrongolo and Pissarides, 2001), $m(u, v)$, as follows:

$$f_t = m(u, v) = \mu \theta_t^\alpha \quad (3)$$

where $\theta_t = v_t/u_t$, the ratio of vacancies and unemployment, is called labour market tightness; μ_t is the efficiency of the matching process; and $0 < \alpha < 1$. The expression for finding rates in (3) ensures a negative and convex Beveridge curve. The elasticity of the matching function α measures how labour market tightness translates into higher job finding rates. The degree of ‘matching efficiency’ determines the job finding rate for a given labour market tightness; the higher the rate at which the unemployed can find new jobs at a given labour market tightness, the more efficient is the matching process.

The Beveridge curve is not sufficient to pin down equilibrium frictional unemployment. It is also necessary to take into account the changing incentives for firms to post vacancies, which ultimately depend on factors affecting labour demand. In this respect, the higher is unemployment, the stronger are the incentives for firms to post vacancies at given labour demand, since filling vacancies becomes easier and less costly. Hence, the labour market

equilibrium is obtained at the intersection of the Beveridge curve and a positively sloped Job Creation curve (JC).

Graph 1 describes equilibrium frictional unemployment in the vacancy-unemployment space in the case of a linear JC curve, which is obtained under conventional functional forms for the matching process (see, e.g., Pissarides, 2000).

Positive (negative) labour productivity shocks, raising (lowering) labour demand, tilt the JC upward (downward), so that steady-state unemployment is lower (higher) and vacancies higher (lower) along an unchanged Beveridge curve. Hence, movements along the curve are associated with the state of the business cycle. When labour demand is weak, employers are reluctant to hire and the number of unfilled vacancies is low while the unemployment rate is high. Conversely, in a tight labour market employers find it difficult to fill open positions, the job vacancy rate is high and the unemployment rate low. These movements along the Beveridge curve are linked to changing incentives to posting a vacancy, which are in turn related to cyclical fluctuations in labour demand.

Shifts of the curve (as opposed to movements along the curve) are instead more likely to be of structural nature and are linked to the efficiency of the workers-to-jobs matching or the rate at which existing jobs are destroyed. An increase in matching efficiency μ_t improves the job finding rate f_t and shifts the Beveridge curve (BC) leftward, while a decrease has the opposite effect. Conversely, a decrease in the job separation rate s_t shifts the curve rightward (i.e., for a given level of vacancies a higher unemployment rate is needed to equate inflows to outflows).

Beveridge curve shifts are therefore related to changes in matching efficiency and in separation rates, which are in turn linked to matching frictions arising from diversity in the composition of labour demand (in terms of skill, sector, geographical location, etc.) compared with that of labour supply, to the technological and institutional infrastructure facilitating the matching between workers and vacant jobs, and to the technological and institutional changes affecting the rate at which firms lay off workers.

Although theory helps identifying structural Beveridge curve shifters, the task of empirically disentangling demand-driven, temporary shocks from structural movements raises a number of issues. First, it is a well-known regularity that the adjustment to labour demand shocks implies a temporary deviation of the unemployment rate from the Beveridge curve (e.g.,

Blanchard and Diamond, 1989). Since vacancies react faster than unemployment, labour demand shocks are followed by counter-clockwise loops in the vacancy-unemployment space without the Beveridge curve being permanently shifted. For instance, the adjustment to a negative labour demand shock is generally followed by an increase in vacancies, while unemployment is still growing. Only subsequently will unemployment start falling, and only when unemployment has fallen sufficiently (and the labour market is sufficiently tight), will vacancies start falling as well. Second, not all changes in job finding and separation rates are structural, and distinguishing permanent from temporary changes can be difficult.

In the following analysis we track empirical Beveridge curves for EU countries, and aim at interpreting the forces underlying their recent evolution, assessing in particular whether the observed shifts in the curves were only temporary or of a more structural nature.

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Graph 1 about here
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3. The vacancy-unemployment relationship across the EU: A few stylised facts

Identifying Beveridge curves requires relatively long data series. Beveridge curves describe a fairly stable relation between vacancies and unemployment only over a sufficiently long time period.

With a view to match unemployment series of EU countries with sufficiently long series on vacancies, OECD vacancy series have been used together with Eurostat Labour Force Survey data on vacancies, and extended backward where necessary on the basis of European Commission Business Survey data (see Appendix A).¹ The data used for the analysis of Beveridge curves are vacancy rates, i.e., the ratio between vacant posts reported and the total number of (occupied and unoccupied) posts.

Graph 2 displays plots Beveridge curves for 27 EU Member States. To visually identify possible breaks in the vacancy-unemployment relation linked with the outbreak of the financial and economic crisis, the chart highlights in different colours the movements in unemployment and vacancies after 2008Q1 from those of the 2000-2008 period, which was

¹ The vacancy rate used in this paper and the vacancy proxy derived from the Business Survey are highly correlated for most countries.

characterised according to existing research by a relatively stable relationship after the inward shifts of late 1990s-early 2000s (European Commission, 2011; ECB, 2012; and Bonthuis et al., 2013).

A number of stylised facts emerge from the inspection of the empirical Beveridge curves. First, the depth of the recession and the sluggishness of the recovery led to lacklustre job creation and a low vacancy rate in most EU countries since end-2009.

Second, for a number of countries the vacancy-unemployment relation appears to follow the typical counter-clockwise looping movements that ensue from labour demand shocks (e.g., negative labour shocks in the early 2000s in Germany, the Netherlands, Poland; positive shocks in Ireland, Italy, the UK). These counter-clockwise movements may take several years to be completed.

Third, for some countries the relationship seems to shift outward (i.e. a higher unemployment rate for a given vacancy rate), which suggests impaired matching efficiency. This is particularly evident for instance in the case of Greece, Spain, Italy, Portugal, where the increase in the job vacancy rate from 2012q1 to 2013q1 has been accompanied by an increase in the unemployment rate. Conversely, developments in Germany, and to a lesser extent in the Czech Republic, Poland, and Slovakia suggest a possible inward shift of the Beveridge curve.

Finally, the labour markets in some countries seem to have adjusted after the 2009 shock following a typical counter-clockwise loop (e.g., Sweden, the Baltics)

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Graph 2 about here
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4. Estimating job matching efficiency and gauging shifts in the Beveridge curve

For the reasons illustrated above, a simple inspection of empirical Beveridge curves may not be sufficient to identify shifts and to derive conclusions on whether such shifts are temporary or permanent.

Previous analyses have sometimes relied on a direct approach in the estimation of Beveridge curve shifts via the use of time dummies. With this approach Beveridge curves are directly estimated from the data, by regressing vacancy rates on unemployment rates and their square

root. The inclusion of time dummies in this specification permits to assess whether the relation between vacancies and unemployment has shifted significantly as compared with the average at a given point in time. This approach is followed for instance in European Commission (2011) and Bonthuis et al. (2013) to track shifts in the euro-area Beveridge curve.

Despite its simplicity, this approach suffers from a number of shortcomings, notably the high sensitivity of estimated shifts to sample size, the impossibility of distinguishing whether shifts are temporary or permanent and whether they originate from job matching or job separations. For the above reasons, recent studies have favoured an indirect approach to assessing Beveridge curve shifts, based on the analysis of job finding and job separation rates and their implications for the position and movements of the Beveridge curve (e.g., Barnichon and Figura, 2010; Sahin et al., 2011; Daly et al., 2012).

Changes in job finding and job separation rates are to some extent structural, being driven by changes in the relative composition of labour demand and supply or by changes in institutions or policies. However, job finding and separation rates are also driven by the cycle, contributing to the overall fluctuations of unemployment.² This is particularly the case for job finding rates. If the labour market is tight (there are a lot of vacancies per unemployed), it is rather easy for job-seekers to find a job. Moreover, in upturns (downturns) the share of long-term unemployed, generally characterised by a lower degree of employability, tends to fall (rise), thus leading to a higher (lower) job finding rates on average.

The cyclicity of job separations is less evident *a priori*, because the number of people who lose their job and the number of those that voluntary quit move in opposite directions over the cycle, so that the behaviour of the overall separation rate is *ex ante* uncertain (see, e.g., Hall, 2005). Nonetheless, there is consensus that in the presence of big, negative shocks job separation rates tend to undergo sudden increases (e.g., Elsby et al., 2010).

In light of the presence of cyclical changes in job finding and separation rates, in order to assess permanent shifts in the Beveridge curve it is necessary to purge observed changes in job finding and separation rates from their cyclical component. The relation between job finding rates and labour market tightness is commonly modelled via a ‘matching function,’ describing a stable relationship between the vacancy-unemployment ratio and the rate at

² See, e. g., Fujita and Ramey (2009), Petrongolo and Pissarides (2008), Elsby et al. (2009), Smith (2011).

which the unemployed find jobs. Under the standard assumption of a Cobb-Douglas functional form for the matching function, the elasticity of the job finding rate with respect to labour market tightness can be estimated from the following equation:

$$\ln f_t = \beta_0 + \beta_1 \ln \theta_t + \varepsilon_t, \quad (4)$$

where f_t is the job finding rate, $\theta_t = v_t/u_t$ is labour market tightness (i.e., the ratio between the vacancy and the unemployment rate), and ε_t is random error. Equation (4) was estimated for each EU country with available data, using quarterly job finding rates estimates obtained with the methodology described in Appendix C, and unemployment data by duration as suggested by Shimer (2012) and Elsby et al. (2013).

The β_1 coefficient in equation (4) provides an estimate of the elasticity of job finding rates to labour market tightness. A majority of papers use the residuals ε_t as an estimate of the matching efficiency parameter μ_t . Such an approach would however be problematic in our analysis because, by the very properties of regressions residuals, the estimated matching efficiency would be highly dependent on the available sample, which differs across the EU. Hence, for the estimation of μ_t we follow the procedure used by Veracierto (2011), and use the requirement for the labour market to be in steady-state [e.g., on the relation described by the theoretical Beveridge curve described in (2)]. The matching efficiency is therefore obtained as

$$\mu_t = \left(\frac{s_t}{u_t} - s_t \right) \left(\frac{1}{\theta_t} \right)^\alpha, \quad (5)$$

which can be computed after estimating parameter α and setting a value for the separation rate s_t .

Table 1 displays the estimated elasticity of the matching function separately for each EU country for which sufficiently long time series are available (see Columns 1 and 2 of the table). With a view to control for the fact that the crisis may have temporarily affected the standard value of the job finding elasticity, estimates are conducted on a quarterly sample spanning the pre-crisis period only (data before 2008).

As expected, the job finding rate moves closely together with labour market tightness. In most countries, the vacancy-unemployment ratio alone accounts for a substantial share of the overall variance of the finding rate, and the estimated elasticity is in general statistically

significant. The estimated elasticity with respect to vacancies is on average around 0.3, which is in the ballpark of values found in the literature (e.g., Petrongolo and Pissarides, 2001).³

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Table 1 about here

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For the sake of the computation of the job matching efficiency in (5), job destruction rates are taken at the average of the pre-crisis period (before 2008), to limit the short-term volatility in the matching efficiency estimate and abstract from the upward jump observed in correspondence with the crisis.

The evolution of the estimated matching efficiency parameter starting from year 2000 is displayed in Graph 3. A number of remarks are in order.

First, it is visible that in a number of countries the degree of matching efficiency fell considerably after the financial crisis. This is particularly evident in the Baltics and Nordic countries, Cyprus, Greece, Spain, France, the Netherlands, Slovenia, Slovakia, and the UK. In a few countries, a downward trend is visible already prior to the crisis, notably in Hungary, Portugal, and Sweden. Conversely, in some countries, matching efficiency did not worsen significantly after the crisis (Austria, Belgium, Romania) or improved considerably (Germany). Finally, it is to note that some improvement in matching efficiency is visible in a few countries toward the end of the sample period, notably in the Baltics, France, and Spain.

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Graph 3 about here

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Turning to the analysis of structural shifts in separation rates, an analytical framework analogous to that for job finding rates is not available. Conceptually, the relation between job separation rates and the cycle is less obvious, although it is a broadly shared view that job separation rates remain roughly stable over relatively long time periods, subject however to sudden jumps corresponding to major economic shocks (Elsby et al., 2010).

In absence of better alternatives, and in line with existing practice (see, e.g., Hobijn and Sahin, 2012), an elasticity of job separation rates to labour market tightness has been

³ The coefficients are higher than those obtained by Hobijn and Sahin (2012) The different time horizon, data frequency, and definition of finding rate may explain this difference. Shimer (2005) instead gets a higher elasticity using a finding rate.

estimated, notably with a view to assess whether labour market slack is generally associated with increased job separation rates. Estimates for the job separation rates are obtained with the methodology described in Appendix C. The specification of the regression equation is analogous to equation (5) above.

Columns 3 and 4 of Table 1 show job separation rate elasticities with respect to labour market tightness, estimated on the pre-crisis period for the available EU countries. It appears that, as a rule, job separation rates do increase when the labour market weakens, most likely in light of a higher frequency of dismissals. However, in a few countries (e.g. Austria, Spain, Romania, Sweden and Slovenia), the separation rate is a-cyclical, consistent with the view that changes in the job finding rates dominate unemployment fluctuations, while separation rates do not always have a clear-cut cyclical pattern (e.g. Hall, 2005; Shimer, 2005). Moreover, the positive coefficient for the UK suggests that during recessions the separation rate in this country could have dropped because the reduction in voluntary quits prevailed over the rise in dismissals.

Overall, the estimates corroborate the view that an estimate of the structural change in separation rates should take into account cyclical factors, due to the fact that separation rates tend to temporarily increase during recessions and phases of major labour market slack.

A gauge of the structural change in job separation rates can be obtained as the difference between actual separation rates and those predicted from labour market tightness on the basis of the estimated elasticities. Graph 4 reports this measure of “cyclically-adjusted separation rates” for the available countries. Job separation rates after the crisis are on average above those predicted on the basis of labour market tightness in all countries except Estonia, while differences for the pre-crisis period are quite negligible. This evidence corroborates the expectation that job separation rates remain relatively constant except during major recessions, where they undergo sudden jumps linked to increased dismissals. The increase in cyclically-adjusted job separation rates over the crisis period is particularly evident and sudden in the countries where the recession is deeper amid current account reversals and tensions in bond markets (Spain, Lithuania, Romania, Greece, Portugal Slovenia, Cyprus). Conversely, relatively stable job separation rates around the level predicted on the basis of labour market tightness are observed for France, Belgium, Germany, and the Netherlands.

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Graph 4 about here
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Overall, on the basis of the above findings, it appears that after the crisis structural changes have occurred in the EU affecting both the efficiency of the job matching process and the rate at which jobs are destroyed. However, such a structural worsening of labour market conditions was not taking place across the board, and cross-country differences were remarkable. Graph 5 provides a graphical synthesis of major developments in matching efficiency and cyclically-adjusted separation rates after the crisis, the main shifters of Beveridge curves. It reports a cross-country scatterplot of the average change in these variables over the 2008-2013 period, as compared with the average that took place over the available period preceding 2008.

There is clear evidence that for a number of countries, notably those where the recession was deeper due to a current account crisis and major bond market tensions (Spain, Portugal, and, to a lesser extent, Greece), the job matching process has become less efficient while at the same time the rate at which jobs are destroyed may have become persistently higher. Matching efficiency fell markedly in Cyprus, while cyclically adjusted separation rates witnessed a major increase in Romania. Less intuitively, there is evidence of outward shifts also in the Beveridge curves of countries that were not concerned by protracted recessions amid bond crises, such as Sweden and Denmark. For some countries, the evidence indicates instead a possible inward shift in the Beveridge curve. Germany, Slovakia, and the Czech Republic exhibit a mild increase in matching efficiency and a reduction in cyclically-adjusted job separation rates. Remarkable increases in matching efficiency are observed for Poland and Bulgaria, while Estonia records a considerable reduction in separation rates.

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Graph 5 about here
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5. Measuring labour market mismatch across skills, industries, regions

Varying degrees of labour market mismatch, and corresponding shifts in the Beveridge curve, are partly the result of persistent imbalances between labour demand and labour supply across a relevant dimension, notably skills, industries or geographical locations.

With a view to gauge the different dimensions of labour market mismatch and the factors affecting labour market efficiency, synthetic time-varying indicators of mismatch by skill, industry, and region have been computed.

Ideally, to measure mismatch one would need data on vacancies and unemployment separately for different skill levels, sectors, and regions. The higher the discrepancy between vacancies and unemployment within a particular skill category, sector, or region, as compared to the one prevailing throughout the whole economy, the higher the associated degree of mismatch. Mismatch indicators built in this vein go back to Mincer (1966) and Jackman and Roper (1987), and have recently been used for the analysis of the US labour market (e.g., Dickens, 2011; Sahin et al., 2012; Lazear and Spetzler, 2012).

Information on both vacancies and unemployment is available at the sectoral level. Eurostat collects, for a number of EU countries, data on job vacancies by sector and it publishes the breakdown of unemployment by industry of last employment. The sectoral mismatch indicator is thus obtained as the sum of deviations between sectors' share in total vacancies and their share in total unemployment (see Appendix D for details).

A higher level of the indicator denotes a higher overall degree of disparity between sectors that offer many vacant jobs and sectors that dismiss many workers.⁴

The same indicator cannot be built for skill mismatch, as data on vacancies differentiated by education level are not available. Hence, following Estevao and Tsounta (2011), a mismatch indicator is constructed on the basis of the disparity of employment and (working-age) population shares by education groups (Eurostat breaks down labour market data in three education groups which broadly correspond to primary education or less, secondary education, and tertiary education).

⁴ A theoretical justification for such an indicator is found in Jackman and Roper (1987), who show that an allocation of workers and jobs that equalizes the vacancy-unemployment ratio across different categories maximizes aggregate hiring.

Similarly, disaggregated vacancy data for regions are not available on a comparable basis across EU countries. Hence, the indicator of regional mismatch used is the coefficient of variation of unemployment rates across regions: the higher its value is, the more heterogeneity there is in the degree of labour market slack across regions. Since the baseline sectoral mismatch indicator is not available for all countries, an alternative sectoral indicator is calculated to the analogy of the regional indicator.

5.1. Mismatch by skills

The falling share in employment of low-skilled labour, the rising share of high-skilled labour, and the relative constancy of medium-skilled labour is common to all countries while the average level of these shares recorded in the past decades differ considerably across countries (see Graph A.1 in the Appendix).

Graph 6 shows how the skill mismatch indicator evolved over time across available EU countries, and points to a number of findings:

- The pre-crisis period was characterised by a reduction in the degree of skill mismatch in most countries, linked mostly to a falling extent of mismatch between the supply and demand for unskilled labour (the excess population share over the employment share has been falling, as shown in Graph A.2 in the Appendix) and for high-skilled labour (the excess employment share has been falling). Exceptions to this trend are however found in Malta, Spain, Portugal, Romania, Sweden, and the UK.
- The crisis was accompanied by rising mismatch in some countries. The trend towards better concordance between the skill composition of labour demand and supply was interrupted in Greece and Ireland, while in Denmark, Spain and Portugal the degree of mismatch continued growing at an accelerated pace. Such increase in mismatch after the crisis in these countries was mostly related to labour demand shifting away from low-skilled labour (already in excess supply) and towards high-skilled labour (in excess demand, see Graph A.2 in the Appendix), with medium-skilled labour playing a different role depending on the countries considered.
- In contrast, in some countries the degree of mismatch fell during the crisis period. This is notably the case for Austria, the Baltics, Belgium, Bulgaria, Germany, Hungary, Poland, Romania, Slovenia, Slovakia, and the UK. Especially noteworthy is the

reduction in the excess supply of low-skilled labour coupled with a drop in the excess demand for medium-skilled labour characterising the Baltics, Poland, Romania (Graph A.2 in the Appendix). In some countries, the skill mismatch started declining only in the most recent years, after an initial increase following the onset of the crisis (Finland, France, the Netherlands, and Sweden).

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Graph 6 about here

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5.2. Mismatch by industries

Before discussing the evolution of sectoral mismatch indicators, it is useful to look at the dynamics in the distribution of unemployment across sectors of previous employment (Graph A.3 in Appendix), which reveal a number of facts.

- First, the distribution of unemployment by sectors of previous employment is fairly stable over time and differences across countries tend to reflect their sectoral specialisation. In a majority of countries most of the unemployed were previously employed in services. In the countries with a relatively strong specialisation in manufacturing, however, a majority of unemployed workers were previously employed in industry (e.g., Hungary, Poland, Slovenia, Slovakia).
- Second, the crisis is associated with shifts in the distribution of unemployed by sector. A surge in the share of unemployed coming from construction activities is visible in the Baltics, Ireland and Spain. In all these countries, construction became indeed one of the major sectors of origin of unemployment after the housing bubble burst in 2007-2008. More recently, however, the share of construction in unemployment was reduced considerably in all countries, which could explain the recent recovery in matching efficiency as recorded in the Baltics and Spain. This finding is consistent with recent evidence from the US, showing that the share of former construction workers contributed massively to the growth in unemployment around 2009 but explained more than 20% of the reduction in unemployment between 2010 and the first half of 2012 (Lazear and Spetzler, 2012).

- Third, industry was instead particularly hit during the crisis in countries where the recession was mostly linked to falling external demand: most visibly in the Czech Republic, Germany, Hungary, Italy, Sweden, Slovenia and Slovakia. Again, it is apparent that these shifts were a temporary phenomenon, no longer visible in most recent years.⁵
- In some countries (e.g., Spain, Hungary, Latvia, Lithuania, the UK) an increasing share of unemployment stems from the public sector and such an increased share exhibits some persistency, which may signal that workers expelled from the public sector may take longer to be re-absorbed in the labour market.
- The share of market services in unemployment increased gradually and persistently since 2008 in a number of countries (notably in Bulgaria, Germany, the Baltic States and the UK).

The baseline sectoral mismatch indicator compares the share of sectors in unemployment with their share in vacancies to provide synthetic information about the degree of mismatch between labour supply and demand. The indicator is only available for a subset of EU countries due to lack of data on sectoral vacancies. Time series are generally shorter than those for the skill mismatch indicator. Graph 7 uncovers a number of facts:

- In a majority of countries where data allow building the indicator, the sectoral measure of mismatch is clearly cyclical: it rises considerably at the initial stage of the recession to drop off subsequently. As discussed above, the onset of the crisis was associated with a sudden shift in the sectoral composition of unemployment which was relatively short-lived especially for construction and industry. This finding corroborates the view that sectoral changes in the composition of unemployment in the aftermath of the crisis of 2008 were mostly a cyclical, rather than a structural phenomenon (Lazear and Spitzler, 2012).
- In a limited number of cases (i.e. Bulgaria, Portugal and Slovakia), cyclical fluctuations occurred around an increasing trend which predates 2008. Excess labour demand in the public sector coupled with excess supply in construction and services

⁵ Anderton et al. (2013) show that the relatively low employment intensity of exports partly explains the more contained unemployment growth in countries where the crisis was felt especially in terms of a fall in external demand.

seems at the origin of the growing mismatch in Bulgaria (see Graph A.4 in the Appendix showing the breakdown of discrepancies between vacancy and unemployment shares), while for Portugal excess demand concerned services coupled with excess supply in the public sector; for Slovakia, the public sector's share in vacancies grew above its share in the unemployment rate while the opposite tendency took place in industry.

Graph A.5 reports an alternative sectoral mismatch indicator (side-by-side with the baseline indicator): the dispersion of unemployment rates by sector. For most countries the development of both indicators is very similar. Among the countries for which the baseline indicator is not available, Spain, France and Ireland exhibit historically high but gradually falling sectoral mismatch since 2008, while the increase in Italy, more modest after 2008, has not reversed itself until the end of the sample period.

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Graph 7 about here
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5.3. Geographic Mismatch

Graph 8 reports the evolution of the coefficient of variation of unemployment rates across regions, used as a measure of geographical mismatch. This dispersion indicator is calculated by Eurostat and is available for the majority of EU countries for the period 1999-2012. The indicator is available both for the NUTS 2 and NUTS 3 regional level.

- It appears that in most countries the crisis has not increased the regional disparities of unemployment. On the contrary, in most countries regional disparities decreased during the recession that started in 2008. Moreover, in the countries where unemployment has increased most in recent years reaching historically high levels (Greece, Spain, Hungary, Italy, Portugal, the UK), the regional dispersion indicator is at historically low levels.⁶ Historically high levels of dispersion in 2008 for Bulgaria, Hungary, Slovakia and to a smaller extent the Czech Republic and Poland also suggest

⁶ The same negative relationship between regional dispersion and the cycle can be observed in some past boom years, too. In Germany, France, Portugal, Spain, Sweden, the UK regional disparities of unemployment reached their maximum around 2001, at the peak of the business cycle.

that high regional disparities of unemployment come about typically in times of high labour demand when some regional labour markets are very tight.

- This evidence is consistent with a known regularity that during recessions unemployment dispersion across regions generally tends to fall, as a relatively larger share of unemployment is generated in low-unemployment regions (e.g., Layard et al., 2005).
- The tendency towards a reduced dispersion of unemployment across regions dates back to before the 2008 crisis in a number of countries (e.g., Germany, Spain, Italy, Portugal, Sweden, the UK). Conversely, in Austria, Belgium, Denmark, and Romania, regional disparities of unemployment failed to decrease in recent years. Among these countries only Denmark registered a sudden increase in unemployment. In Germany, unemployment and its regional disparity have been decreasing in parallel, as a result of disproportional employment gains in new *Bundesländer* that were characterized by relatively high unemployment rates in 2008.

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Graph 8 about here

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6. Analysing the drivers of matching efficiency

How are the mismatch indicators presented in the previous section related to the efficiency of labour market matching? We proceed with the analysis in two steps. First, we run country-level univariate time series regressions relating matching efficiency separately with each of the mismatch indicators. The aim is to acquire information on co-movements, allowing for country-specific relations. In a second step, we run multivariate regressions aimed at analysing the determinants of matching efficiency dynamics. Mismatch indicators are used simultaneously as explanatory variables, together with the share of long-term unemployment, and indicators of active and passive (income support for the unemployed) labour market policies. Due to the reduced sample size, multivariate regressions are run on the whole panel of available EU countries.

6.1. Linking mismatch indicators to labour matching efficiency: Evidence from country-level univariate regressions

The estimation of matching efficiency and the computation of mismatch indicators across skills, industries and regions, permits to assess the dimension along which there was a change in labour market mismatch across EU countries. Table 2 reports the results from country-level regressions of matching efficiency on, respectively, skill, sectoral, and regional mismatch indicators. While the matching efficiency series and the skill and sectoral mismatch series are available on a quarterly basis, the regional mismatch indicator is collected on an annual frequency. To ease the comparison, all series have been converted into annual frequency.

It appears that in a majority of countries, skill mismatch is negatively and significantly related with matching efficiency, and, by itself, accounts for a relevant fraction of the variance - matching efficiency, as revealed by the R^2 statistic. The role of skill mismatch appears to have driven matching efficiency downward to a relatively large extent in Spain, Greece and Portugal, while in Germany reduced skill mismatch contributed to improving matching efficiency. Conversely, in Hungary and to a lesser extent Austria the relation between skill mismatch and matching efficiency was a significantly positive one. In particular, the continued improvements along the skill mismatch dimension in Hungary were matched by a considerable drop in the efficiency of the labour matching process.

Table 2 shows the relation between matching efficiency and the standard deviation of unemployment across sectors of origin (Graph A.5). This sectoral mismatch indicator was chosen for the regression analysis since the indicator based on the disparity between unemployment and vacancies across sectors is not available for a number of countries.

A number of facts stand out. First, the relation of industry mismatch with matching efficiency appears weaker than that of skill mismatch. Fewer countries exhibit a significantly negative relationship and the fraction of the variation of matching efficiency explained by industry mismatch is often low. In Greece, Spain, and Portugal, industry mismatch appears to have played a role in the drop in the efficiency of the matching process in the labour market during the crisis. For these countries, the relation is significantly negative, and the R^2 statistic relatively high.

Finally, concerning the relation between matching efficiency and regional mismatch, it appears, counter-intuitively, that in a majority of countries the correlation is positive, and

relatively strong. An explanation of positive correlations may be that regional mismatch is not a main driver of matching efficiency. (In fact, as the analysis reported in Table 3 shows, regional mismatch is not significant in a multivariate regression explaining matching efficiency.) But it is also possible that such a positive relation is spurious, and linked to the fact that both regional unemployment dispersion and the degree of matching efficiency have fallen with the surge in overall unemployment after the crisis.

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Table 2 about here

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6.2. Drivers of matching efficiency: Evidence from panel multivariate regressions

With a view to take into account the simultaneous influence of multiple factors that affect matching efficiency, multivariate regressions on annualised data are carried out across the whole available sample of EU countries.⁷ Table 3 shows the results.

To obtain stationary time series the matching efficiency indicator is treated in time differences. Two lags of the dependent variable are included among the explanatory variables to capture persistency and possible cyclical patterns.⁸ The changes in mismatch indicators for skills, sectors, and regions are included simultaneously among the explanatory variables, with the aim of assessing whether these dimensions of mismatch mattered for the evolution of matching efficiency, while taking into account the interplay among different mismatch dimensions in a multivariate regressions framework.

The change in the long-term unemployment ratio (i.e., the number of unemployed searching for a job for more than one year divided by the total number of unemployed) aims at assessing whether the changing composition of unemployment in terms of duration matters for job finding rates and therefore for matching efficiency, the expectation being that the long-term unemployed are less likely to find a job.

Two policy variables are also included among the regressors. The change in the implicit replacement rate of ALMPs (i.e., the annual average ALMP spending per job seeker divided

⁷ Panel regressions are needed to overcome the short time series and the limited number of degrees of freedom.

⁸ Cyclical unemployment patters are generally satisfactorily captured by second-order auto-regressive processes.

by per-capita income) aims at testing the hypothesis that an increase in the availability of training, activation, job search and placement assistance, hiring subsidies and public work schemes helps raising job matching efficiency. The variable so defined provides an *ex-post* measure of the extent to which ALMP spending “replaces” income over a one-year period for the average jobseeker. The change in the implicit replacement rate of unemployment benefits, on the other hand, is included to test the hypothesis that an increase in per-capita spending in income support for the unemployed reduces the willingness for the jobseekers to take up jobs, thereby reducing the efficiency of job matching.

Across the whole sample, all variables have the expected sign, except for unemployment dispersion across regions. The coefficient is however highly insignificant, suggesting that regional mismatch did not play a major role over the sample period. Unemployment benefits also appear to be largely insignificant, while the *t*-test for the skill mismatch indicator is not significant but relatively close to the 10% significance level.

The long-term unemployment ratio appears highly significant. As the fraction of the long-term jobseekers rises, the average speed at which the unemployed find a job tends to fall. A high degree of significance is reached also by the ALMP variable. The indicator of sectoral mismatch reaches significance at the 10% significance level. Overall, the empirical equation explains almost 56 per cent of the variation in the change of matching efficiency.

Splitting the sample for periods before and after the crisis (columns 2 and 3), it appears that after the crisis, matching efficiency has become more sensitive to long-term unemployment, skill mismatch, and ALMPs.

As opposed to ALMPs, which exhibit a significant coefficient, unemployment benefits do not appear to affect matching efficiency in specifications (1)-(3). In column (4), an alternative unemployment benefit indicator is used, which computes generosity *ex-ante* rather than *ex-post*, and which is constructed on the basis of the net replacement rates foreseen by the legislation for a single worker earning the average wage. This *ex-ante* measure is the sum of all *ex-ante* net replacement rates associated with different unemployment durations multiplied by the maximum eligibility time, and thus represents the total income support available to the unemployed over the unemployment spell, as a share of labour income. Results show that this *ex-ante* unemployment benefit measure reaches statistical significance at 10% level. Hence, the hypothesis that more generous unemployment benefits could depress job finding rates by raising jobseekers’ reservation wages that was confirmed in recent analyses for the United

States (e.g., Elsby et al., 2010; 2011), also receives some support when tested on a panel of EU data.

Finally, columns (5) and (6) show that results appear robust with respect to the inclusion of the regional mismatch indicator in the empirical specification and with respect to the choice of the sectoral mismatch indicator (qualitatively similar results are obtained when using the standard deviation of unemployment across sectors or the sector mismatch indicator based on the discordance between unemployment and vacancies across industries).

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Table 3 about here
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6. Conclusions

This paper makes a number of steps forward in the analysis of the dynamics of labour market matching across EU countries.

The paper analyses first the main features of the Beveridge curves of EU countries and their evolution. A new database on vacancy and unemployment rates for EU countries has been compiled from multiple sources, which allows for an analysis of labour market matching over a sufficiently long time period to compare pre- and post-crisis outcomes. The behaviour of the Beveridge curve is highly heterogeneous across countries of the euro area. In some countries, notably Spain, Greece, Italy, Portugal, the UK, it appears that the Beveridge curve has shifted outward in the post-crisis period. Conversely, there is clear evidence of an inward shift in a few countries, notably Germany.

With a view to shed light on the temporary versus permanent shifts in labour market outcomes, a measure of the efficiency of the job matching process has been estimated, and cyclical changes in job separation rates have also been distinguished from more permanent ones with the construction of cyclically-adjusted series of job separation rates. Overall, there is evidence of a considerable degree of heterogeneity in terms of Beveridge curve shifts across EU countries, with evidence of structural worsening of labour market matching in the euro-area countries mostly hit by the debt crisis, while in some other countries (notably Germany) the evidence rather points in the direction of improved matching efficiency.

The construction of mismatch indicators along the skill, industry, and regional dimensions permits to uncover a number of findings relating the microeconomic underpinnings of the transformations in the degree of efficiency of labour matching in the post-crisis period.

- Skill mismatch worsened in a majority of the EU countries with serious unemployment problems, especially in view of the fact that the demand for unskilled labour which was already insufficient to employ existing workers before the crisis fell further, while the labour market for skilled labour became even tighter. The Baltics and few other New Member States appear to be an exception, as the degree of slack in the labour market of the unskilled fell after the crisis of 2008-2009.
- The degree of mismatch across economic sectors rose steeply with the outburst of the crisis in a majority of EU countries for which data are available, notably linked to increased job shedding in construction and industry. In most countries, however, a relatively rapid fall in the degree of industry mismatch is observable. This corroborates the view that in the EU, like in the US (e.g., Lazear and Spetzler, 2012), the changing composition of unemployment in terms of sectors in the aftermath of the crisis was to a large extent a cyclical, temporary phenomenon.
- Regional mismatch fell in most EU countries. This is a regularity observed also in previous recessions in advanced economies (Layard et al., 2005): job losses are relatively more numerous in regions providing more jobs and characterised by lower unemployment rates.

The analysis of the main drivers of matching efficiency reveals that the lengthening of unemployment spells was a significant driver of matching efficiency especially after the crisis, and that skill and sectoral mismatches also played a role. Active Labour Market Policies are associated with increased matching efficiency, and some support is found in favour of the hypothesis that more generous unemployment benefits reduce the efficiency of labour market matching by reducing the willingness of unemployed workers to take up jobs.

The above evidence conveys a number of messages with relevant policy implications.

In light of the considerable heterogeneity in the post-crisis dynamics in labour market matching, undifferentiated policy responses for the EU or the euro area would work only to a certain extent. Tailor-made responses are needed, both in terms of ambition and composition across policy instruments.

In the countries where labour market matching deteriorated most, namely, the countries deeply affected by the rebalancing and deleveraging process, it is important that the dynamics in real wages play in favour of the re-absorption of unemployment, that incentives to take up jobs remain high, and that taxation and labour regulations do not hamper incentives to create jobs.

To prevent a persistent fall in the labour contribution to growth looking forward, efforts should be stepped up to facilitate re-skilling, and to avoid that the long-term unemployed and other vulnerable categories (notably the youth) exit from the labour force.

Adequate means should be ensured to Active Labour Market Policies, which should be used effectively with a view to ease mismatch along the skills dimension, to ensure the activation of benefit recipients, and to prevent the exit from the labour force of the long-term unemployed and vulnerable categories.

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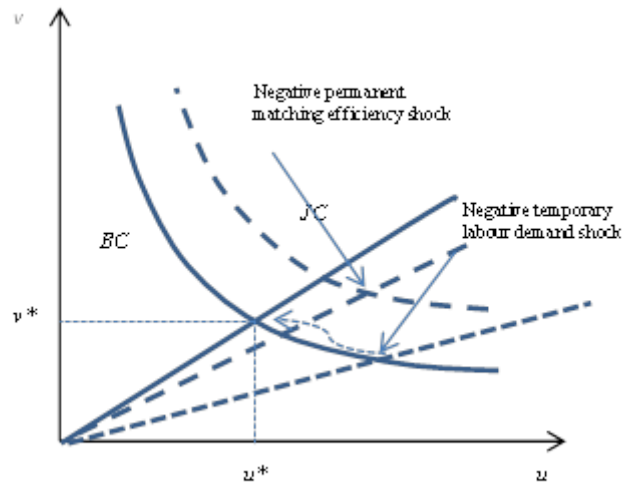
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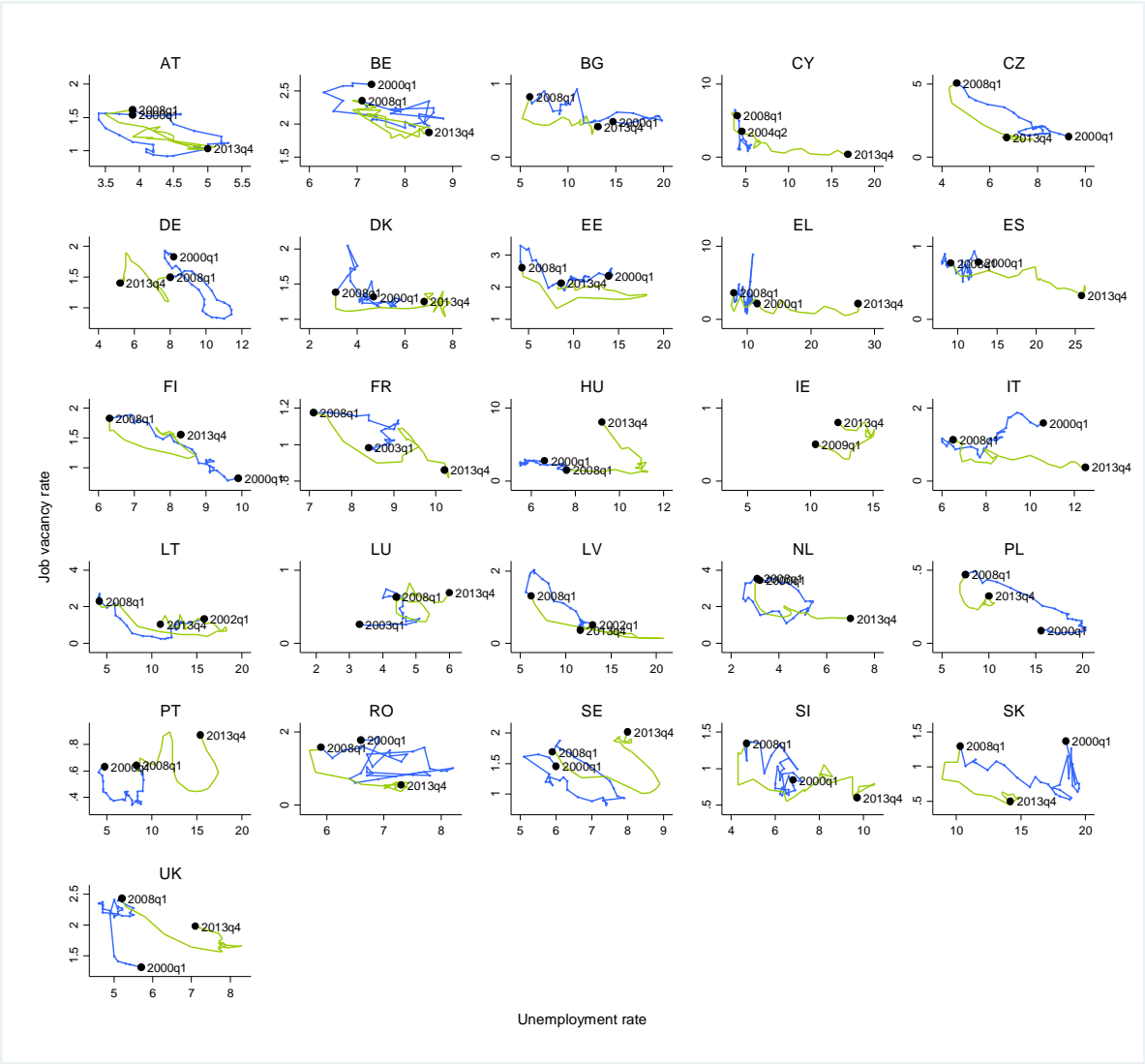
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Graph 1: The Beveridge curve and adjustment to shocks



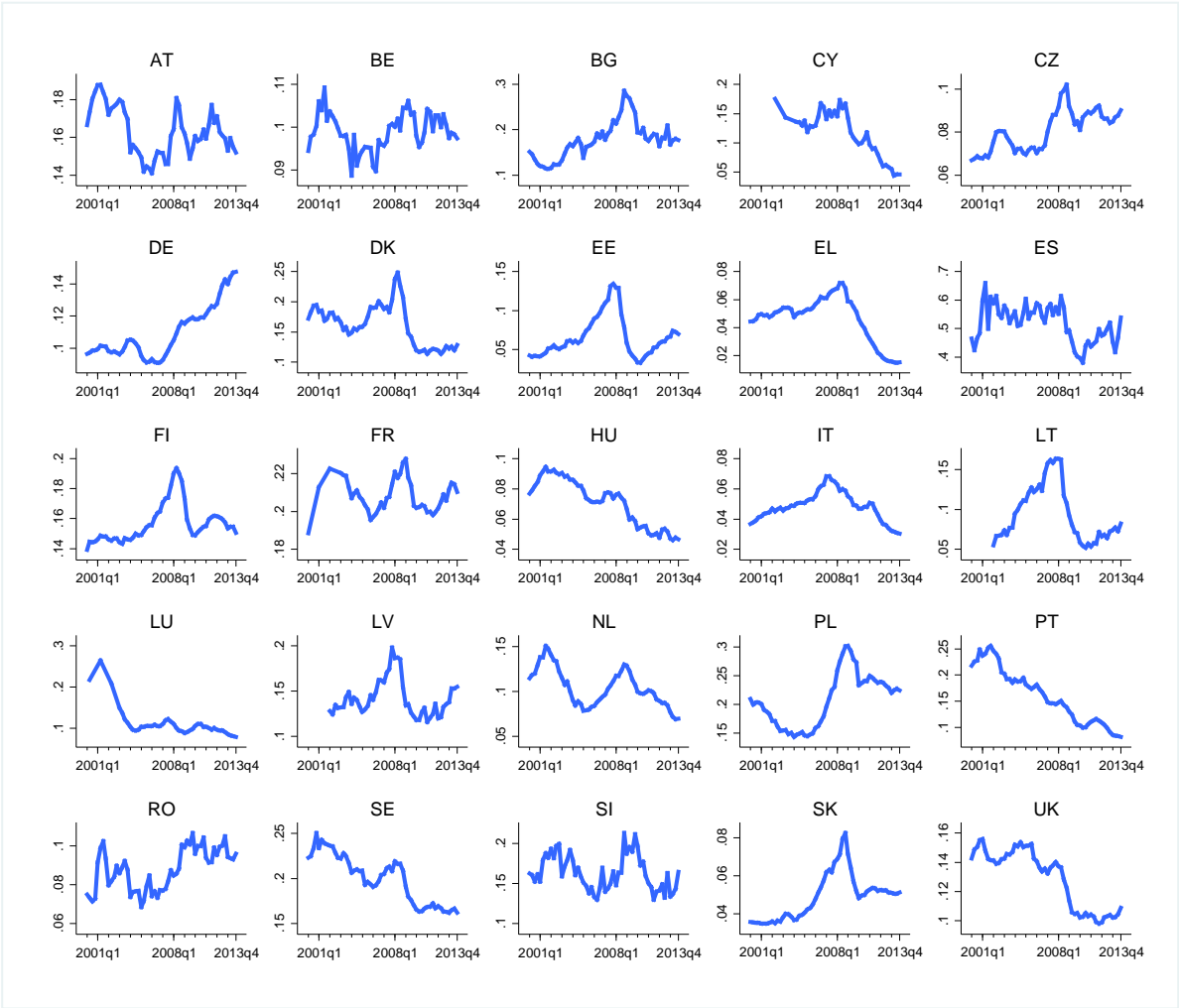
Notes: The graph presents the case of a negative shock assumed to be temporary, so that unemployment initially rises and then gradually moves back to u^* , producing a counter-clock wise movement in the (u, v) space. Increases (reductions) in the matching efficiency or reductions (increases) in the separation rate shift the BC curve inward (outward). Notice also that the JC is affected also by the job matching efficiency (it is tilted upward) and by the separation rate (downward tilt). The graph presents the case of an increase in matching efficiency.

Graph 2: Empirical Beveridge curves



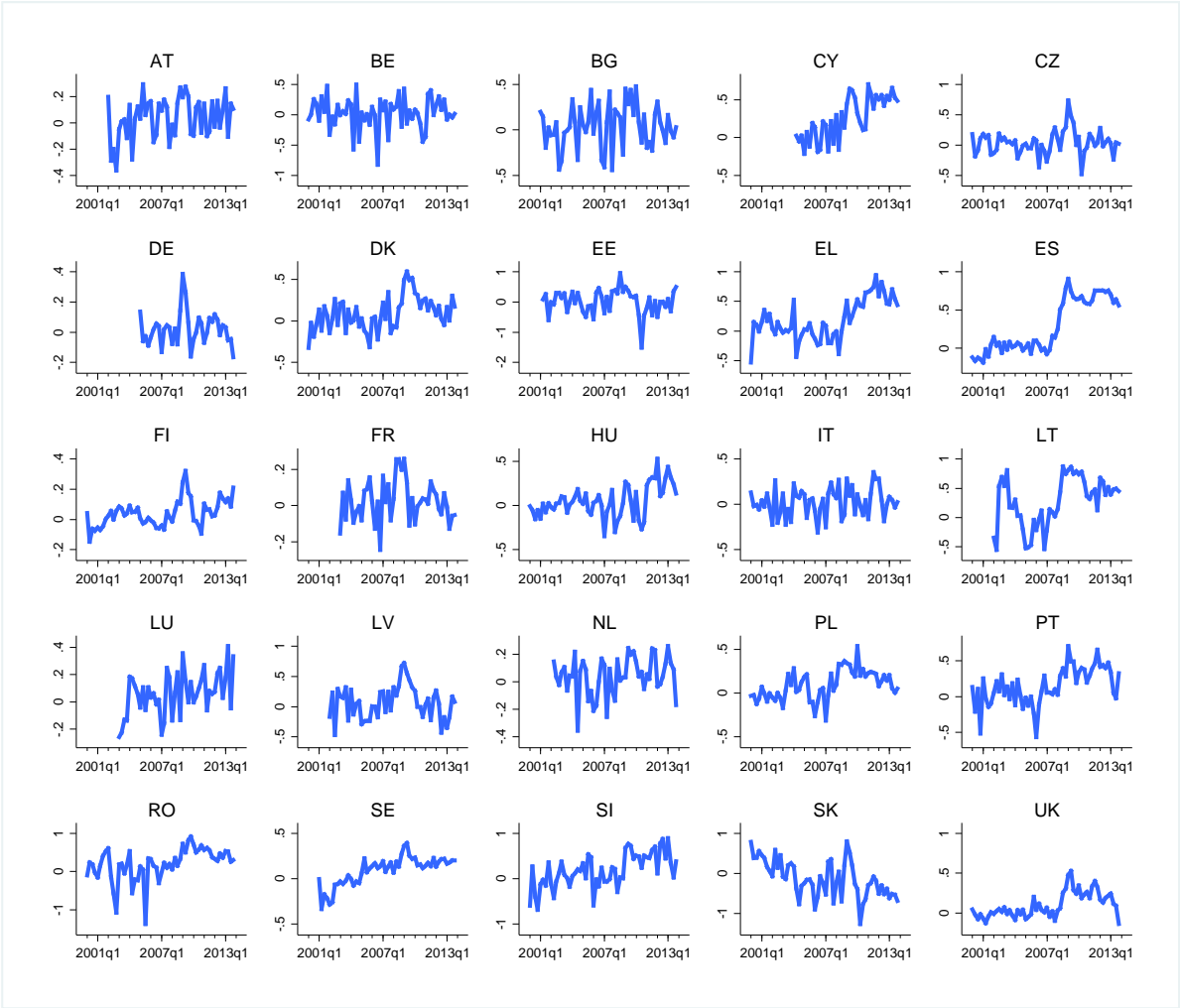
(1) The job vacancy rate is the ratio between vacant posts reported and the total number of posts (vacant and occupied). See Appendix B for details on sources and the construction of the vacancy rate.

Graph 3: Job matching efficiency



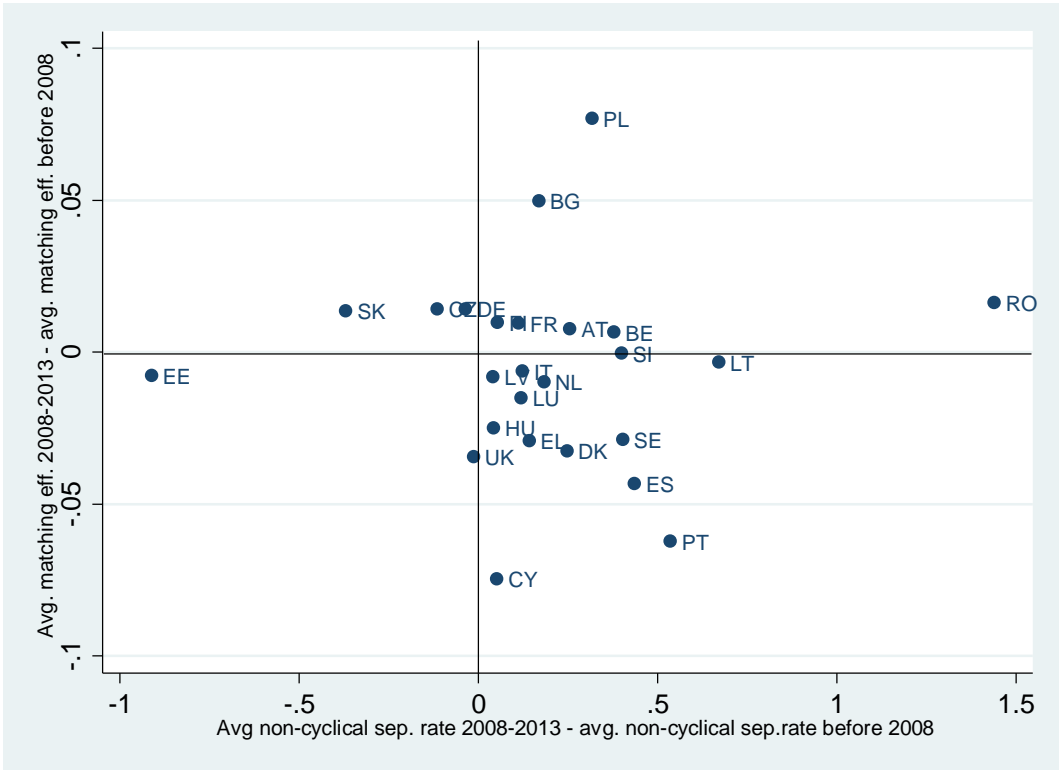
(I) See Section 4 for the computation of matching efficiency.

Graph 4. Cyclically-adjusted job separation rates

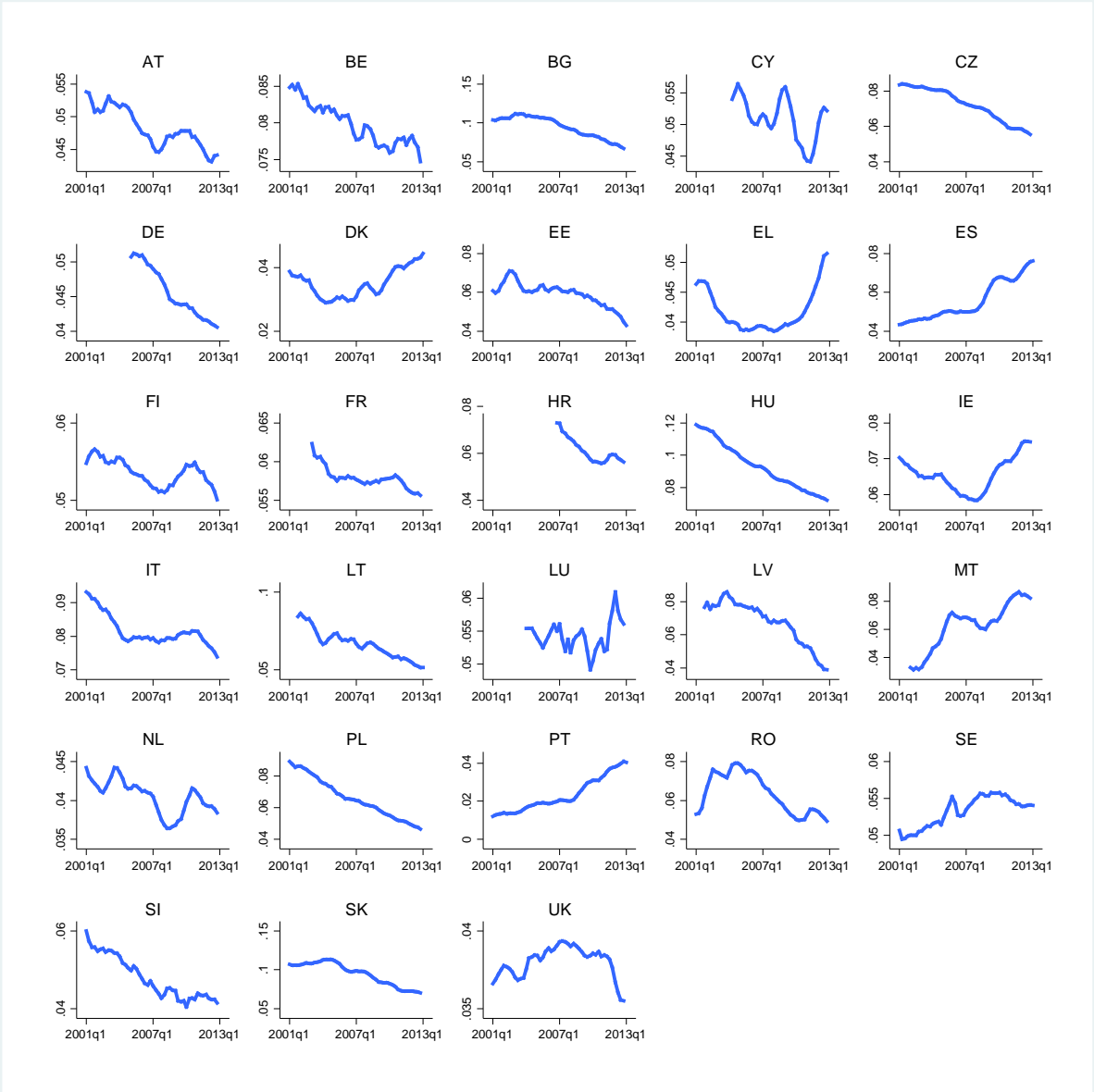


(1) See Section 4 for the computation of cyclically-adjusted job separation rates.

Graph 5. Gauging Beveridge curve shifts from changes in matching efficiency and cyclically-adjusted job separation rates

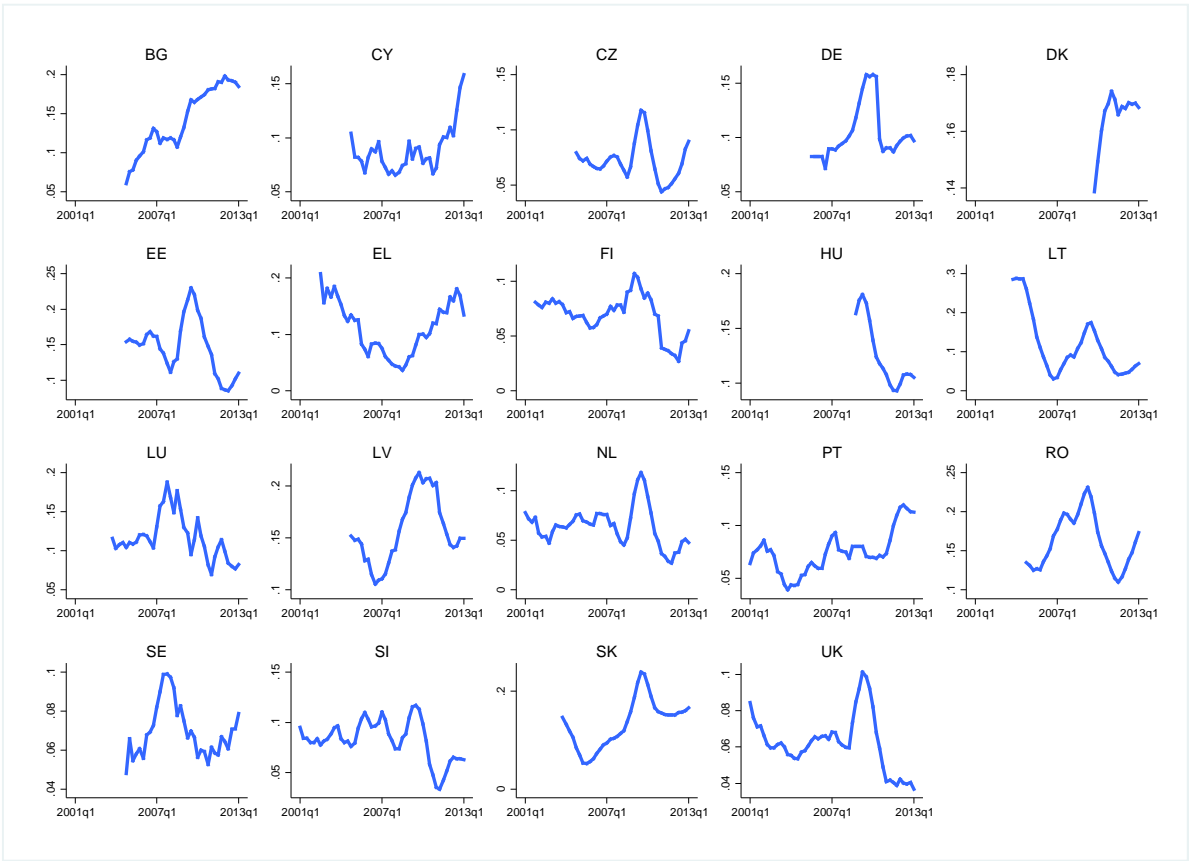


Graph 6: Skill mismatch indicator



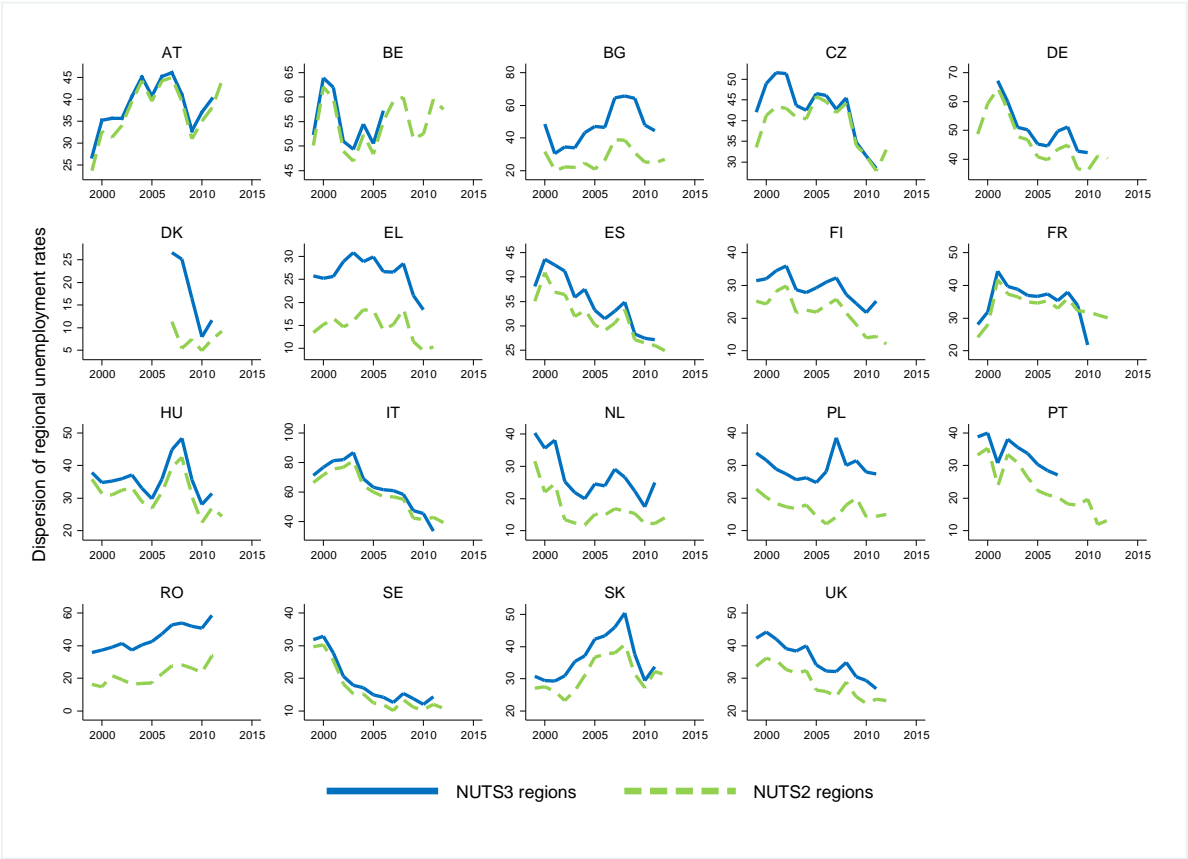
(1) See Appendix D for the computation of the indicator.

Graph 7: Sectoral mismatch indicator



(1) See Appendix D for the computation of the indicator

Graph 8: The regional dispersion of unemployment rates, 1999-2012



(1) See Appendix D for the computation of the indicator.

Table 1: Elasticities of job finding and separation rates with respect to labour market tightness

	(1)	(2)	(3)	(4)
	Job finding rate elasticity		Job separation rate elasticity	
	Regression coefficient	Adj. R^2	Regression coefficient	Adj. R^2
Austria	0.26***	0.18	-0.22	0.01
Belgium	0.41***	0.28	-0.80**	0.14
Bulgaria	0.45***	0.51	-0.55***	0.55
Cyprus	0.097*	0.15	-0.09*	0.11
Czech Republic	0.22***	0.55	-0.38***	0.57
Germany	0.33***	0.85	-0.38***	0.71
Denmark	0.24***	0.48	-0.38***	0.23
Estonia	0.13**	0.19	-0.82***	0.60
Greece	-0.01	0.00	-0.03	0.00
Spain	0.63***	0.64	0.06	0.00
Finland	0.14***	0.65	-0.21***	0.63
France	0.51***	0.56	-0.69**	0.22
Hungary	0.18***	0.16	-0.40***	0.47
Italy	-0.21	0.03	-0.24**	0.07
Lithuania	0.20***	0.80	-0.13*	0.08
Luxembourg	0.10	0.03	-0.15*	0.08
Latvia	0.26***	0.81	-0.15**	0.21
Netherlands	0.19***	0.46	-0.37***	0.52
Poland	0.25***	0.89	-0.29***	0.76
Portugal	0.37***	0.74	-0.42***	0.39
Romania	0.28**	0.08	0.00	0.00
Sweden	0.21***	0.26	-0.13	0.07
Slovenia	0.58***	0.70	-0.01	0.00
Slovakia	0.05	0.03	-0.82***	0.32

(1) The table shows the coefficients and R^2 statistic of the regressions for the finding and separation rates on labour market tightness (i.e., the ratio of vacancies to unemployment).

(2) *, **, *** stand for statistical significance at the 10%, 5% and 1% level.

(3) Sample period: 2000q1-2007q4 where available.

Table 2: The elasticity of matching efficiency with respect to mismatch indicators: evidence from univariate country-level regressions

	Skill mismatch			Sector mismatch			Regional mismatch		
	Regression coefficient	Adj. R^2	No. obs.	Regression coefficient	Adj. R^2	No. obs.	Regression coefficient	Adj. R^2	No. obs.
Austria	0.49	0.13	13	-0.08	-0.11	10	-0.31*	0.23	13
Belgium	-0.15	-0.06	13	0.09	-0.02	12	0.13	0.09	13
Bulgaria	-0.77*	0.2	12	-0.04	-0.11	11	0.72**	0.39	13
Cyprus	1.07	0.05	8	-0.19	-0.16	8			
Czech Republic	-0.62***	0.51	13	-0.02	0.09	12	-0.39*	0.2	13
Germany	-1.72***	0.96	8	-0.76***	0.7	8	-0.29	0.19	13
Denmark	-0.9**	0.24	13	-0.26	-0.04	12	0.03	-0.24	6
Estonia	0.59	-0.01	13	0.03	-0.09	12			
Greece	-3.25***	0.59	13	-1.22***	0.63	12	0.66**	0.31	13
Spain	-0.39**	0.35	13	-0.16***	0.52	12	0.35	0.12	13
Finland	-2.04***	0.58	13	-0.17**	0.28	12	-0.04	-0.06	13
France	0.66	0.03	10	0.03	-0.1	10	0.3**	0.41	13
Hungary	1.31***	0.87	12	-0.01	-0.09	12	0.7*	0.26	13
Italy	-0.59	-0.01	12	-0.41	0.09	12	-0.01	-0.09	12
Lithuania	0.8	-0.02	11	-1.04*	0.2	11			
Luxembourg	-0.76	0.03	9	-0.07	-0.05	10			
Latvia	0.19	0.03	11	0.04	-0.1	11			
Netherlands	0.16	-0.09	13	0.17	-0.08	12	0.45*	0.26	13
Poland	-0.69**	0.32	13	-0.61**	0.4	12	0.26	-0.06	13
Portugal	-0.79***	0.93	13	-0.86***	0.63	12	0.81***	0.69	13
Romania	-0.46**	0.38	13	0.23*	0.22	12	0.28**	0.34	13
Sweden	-0.9***	0.31	13	0.17	-0.03	12	1.09***	0.52	13
Slovenia	0.15**	-0.05	13	0.13	0.01	12			
Slovakia	-2.28	0.46	12	0.64	0.08	10	0.29***	0.55	13
United Kingdom	0.44	-0.08	13	-0.28	-0.04	12	0.76***	0.6	13

(1) *, **, *** stand for statistical significance at the 10%, 5% and 1% level.

(2) Sample period: 2000q1-2013q1 where available.

(3) The sectoral mismatch indicator used in the analysis is the alternative indicator shown in Graph 5 (i.e., the standard deviation of unemployment across sectors) as it is available for all countries in the sample.

Table 3: Drivers of matching efficiency: evidence from regression analysis

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable: change in matching efficiency	Whole sample	Before 2008	After 2007	Alternative UB indicator	Regional mismatch indicator excluded	Alternative sectoral mismatch indicator
Dep. variable 1 lag	0.0382 [0.393]	-0.0443 [-0.168]	0.00542 [0.0616]	0.0643 [0.536]	0.143 [1.537]	0.111 [0.993]
Dep. variable 2 lags	-0.100* [-1.736]	-0.0981 [-1.416]	-0.489 [-1.445]	-0.103 [-1.727]	-0.140** [-2.627]	-0.188** [-2.485]
Change in long-term unemployment ratio	-0.135** [-2.240]	-0.0340 [-0.387]	-0.131* [-1.872]	-0.132* [-1.762]	-0.0854** [-2.121]	-0.0860** [-2.754]
Change in unemployment rate dispersion across sectors	-3.378* [-1.856]	-1.680 [-0.844]	-3.999 [-1.045]	-4.053* [-1.816]	-0.909 [-0.860]	
Change in unemployment rate dispersion across regions	1.806 [0.393]	1.527 [0.387]	2.200 [0.292]	1.794 [0.362]		
Change in skill mismatch indicator	-1.113 [-1.501]	0.108 [0.228]	-2.080* [-1.738]	-1.630 [-1.274]	-1.026* [-1.797]	-0.604 [-1.523]
Change in implicit replacement rate of ALMPs	0.218** [2.522]	0.0757 [1.330]	0.325** [2.707]	0.212** [2.386]	0.242*** [4.536]	0.224*** [3.580]
Change in implicit replacement rate of unemployment benefits	-0.0403 [-0.376]	0.0757 [1.014]	-0.101 [-0.859]		-0.0480 [-0.765]	-0.131 [-1.685]
Change in ex-ante unemployment benefit generosity				-0.212* [-2.006]		
Change in sectoral mismatch indicator						-0.0972* [-1.884]
Constant	-1.610* [-1.870]	0.832** [2.652]	-0.758 [-0.626]	-0.852* [-1.876]	-0.248 [-0.782]	-0.563 [-0.941]
Observations	143	78	65	118	187	103
R-squared (within)	0.556	0.519	0.667	0.585	0.548	0.553
Number of countries	19	18	19	18	25	17

(1) *, **, *** stand for statistical significance at the 10%, 5% and 1% level. Estimates are obtained from fixed-effects panel regressions, with standard errors robust with respect to heteroskedasticity and non-independence within countries. All regressions include country and year effects.

(2) The definition of the skill and regional mismatch indicator is provided in Appendix D. Implicit replacement rate of ALMPs: average expenditure in ALMPs per unemployed / GDP per capita. (Source: Eurostat LFS, DG ECFIN AMECO database). Implicit replacement rate of unemployment benefits: average expenditure in unemployment benefits and early retirement schemes per unemployed / GDP per capita. (Source: Eurostat LFS, DG ECFIN AMECO database).

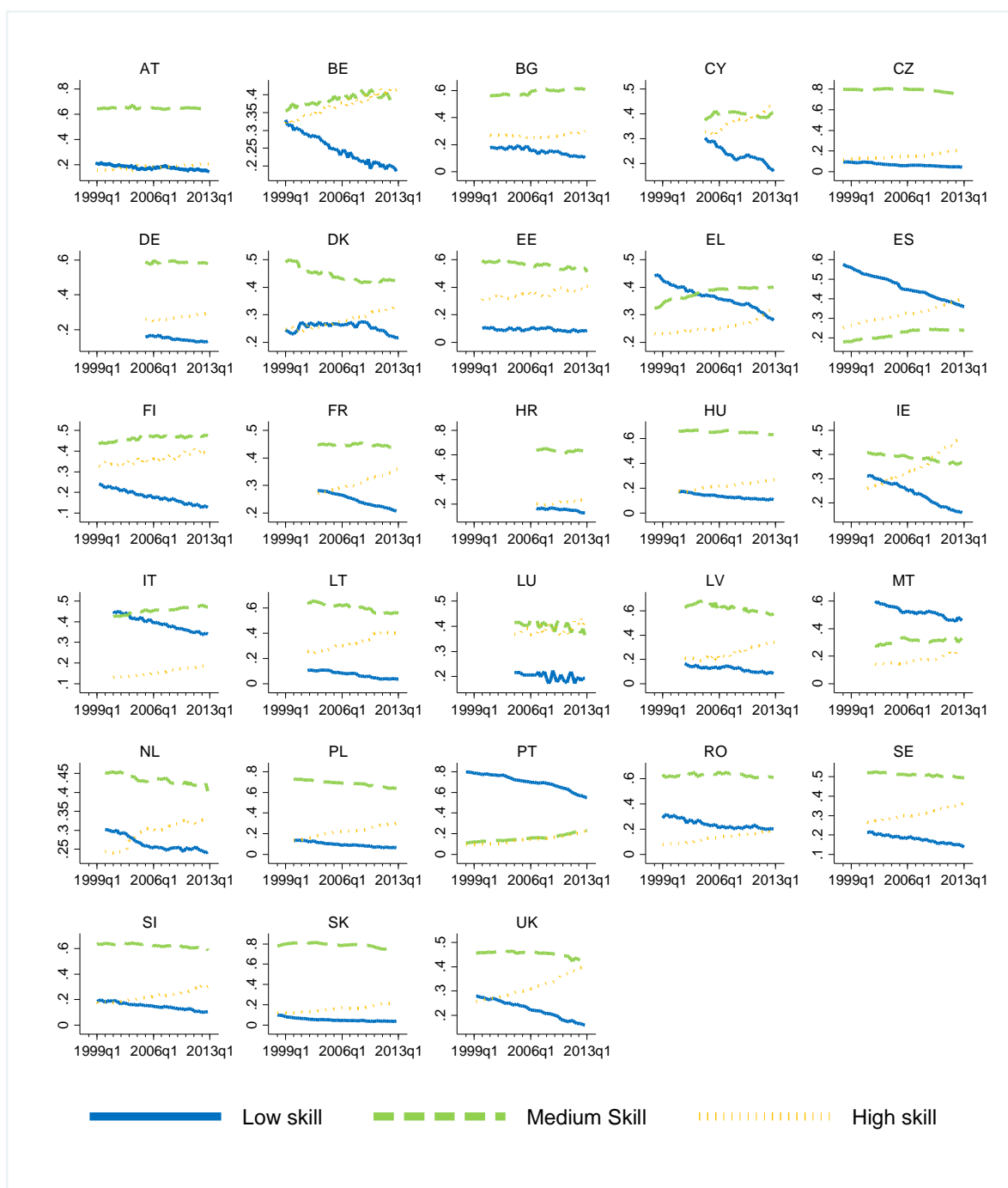
(3) Ex-ante unemployment benefit generosity: The indicator measures ex ante the maximum potential income support available over the unemployment spells for those unemployed that fulfil all eligibility criteria (see Stovicek and Turrini, 2012). It is constructed based on the formula:

$$UBgenerosity = \sum_{i=1}^k nrr_{UI,i} * duration_{UI,i} + nrr_{UA} * duration_{UA}$$

where nrr stands for net replacement rate, UI and UA at the pedix of variables denote, respectively, unemployment insurance and unemployment assistance, the index i refers to the different replacement rates depending on the length of the unemployment spell. (Source: OECD-European Commission Tax and Benefit project).

APPENDIX A: Background graphs

Graph A.1: Share of skill groups in total employment, 1998-2013

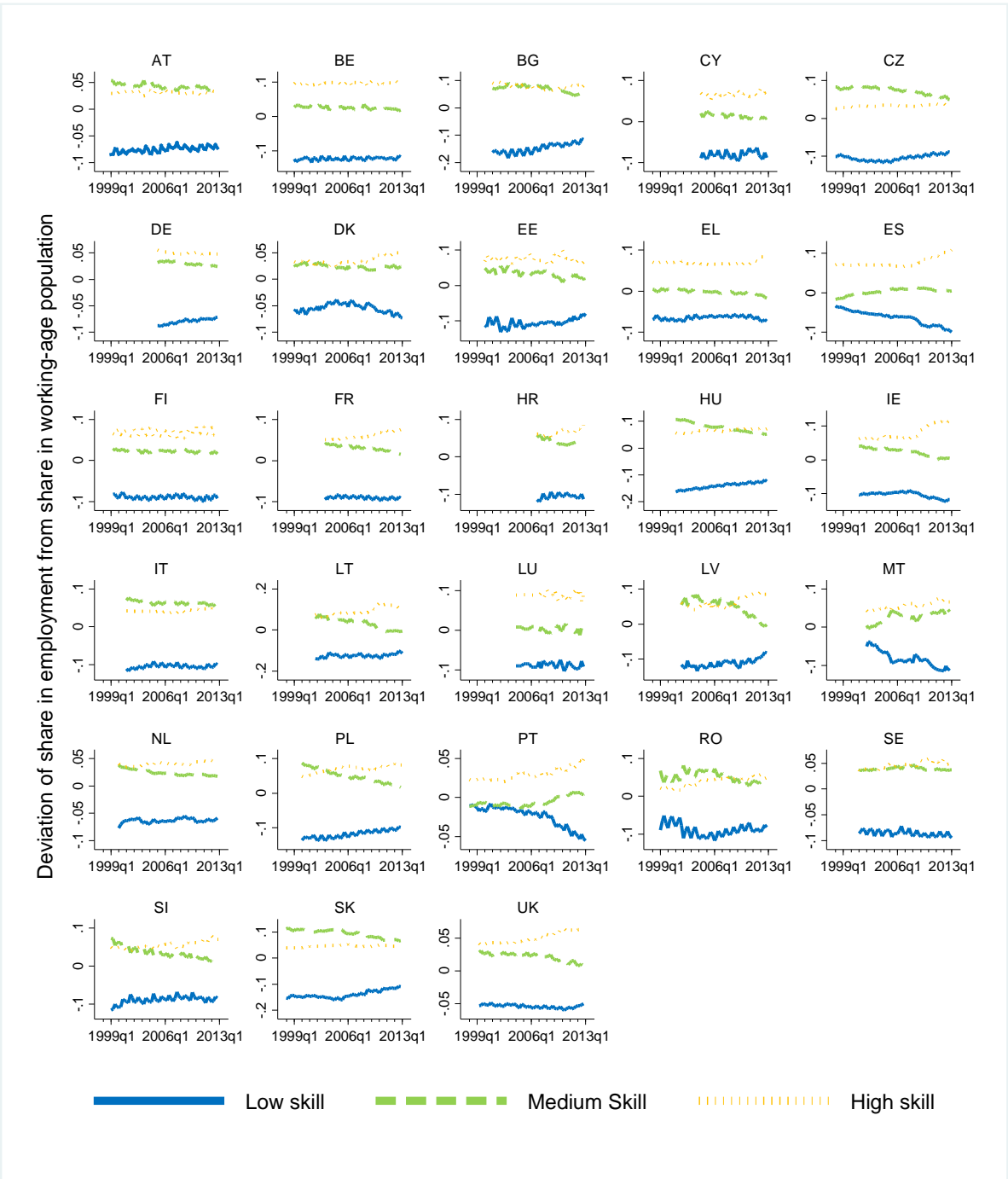


(1) Methodological breaks in the time series of individual countries have been adjusted for.

(2) Seasonally not adjusted data.

Source: Eurostat, Labour Force Survey, own calculations.

Graph A.2: Deviation of skill groups' share in employment from their share in population

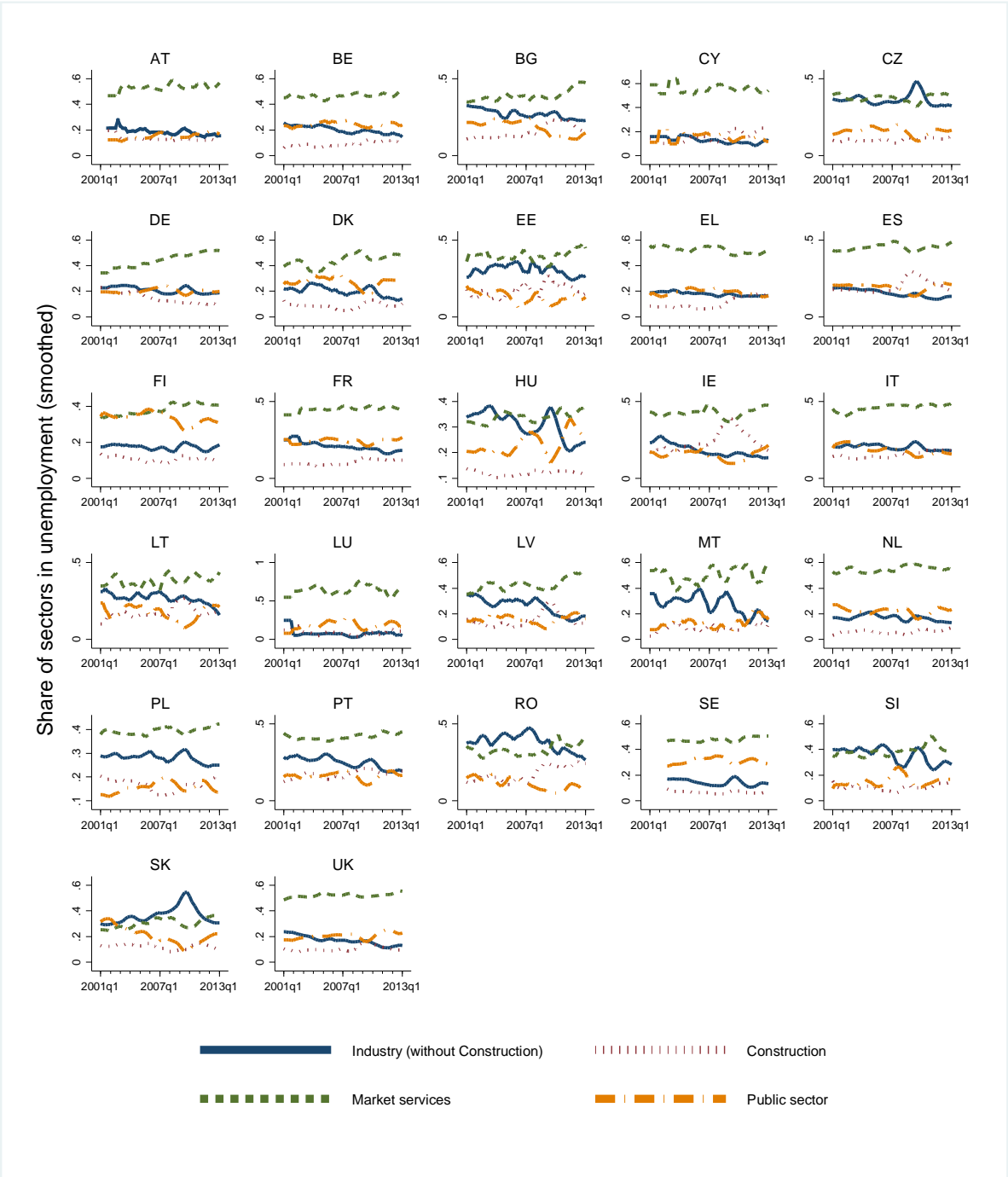


(1) Methodological breaks in the time series of individual countries have been adjusted for.

(2) Seasonally not adjusted data.

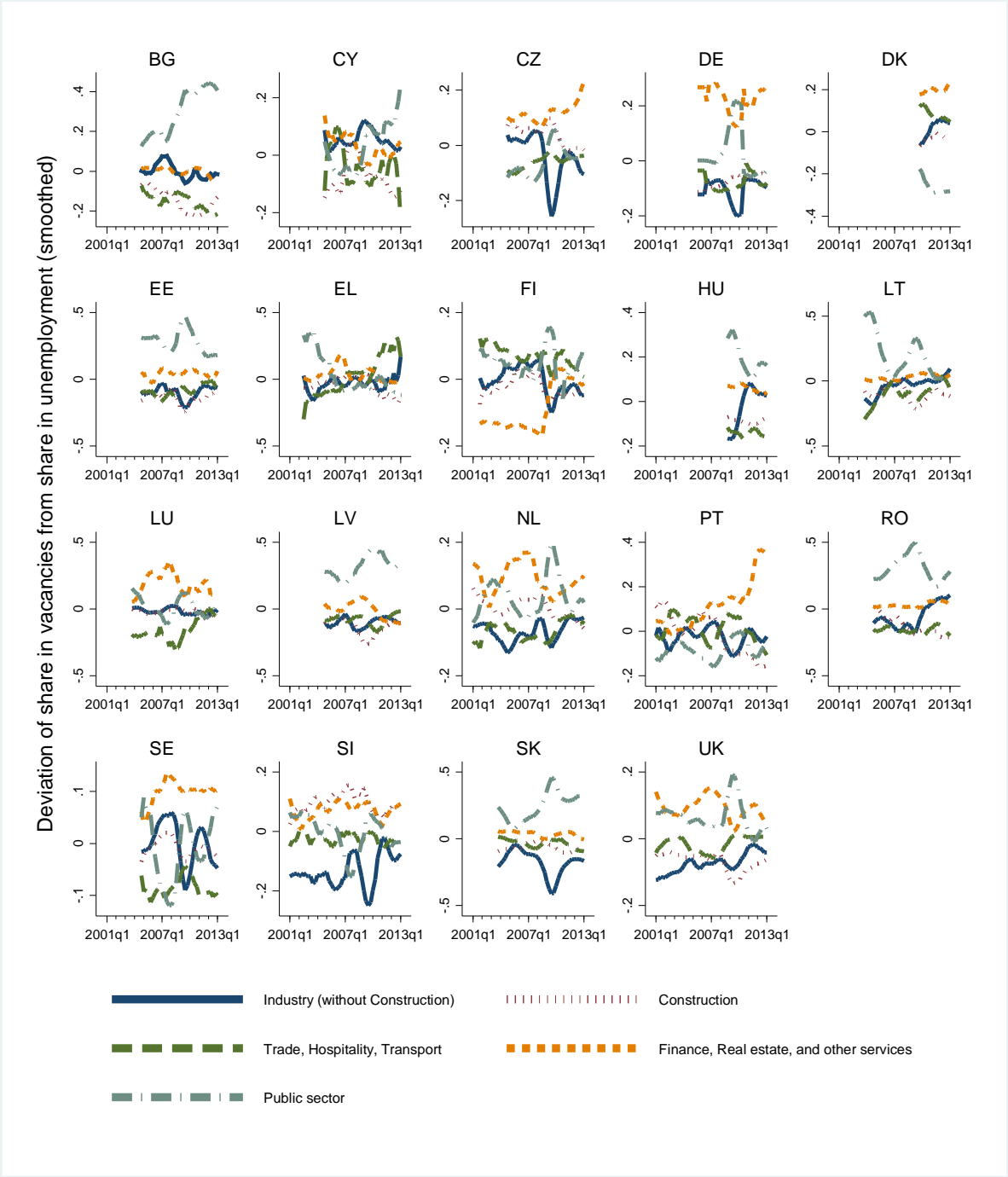
Source: Eurostat, Labour Force Survey, own calculations.

Graph A.3: The share of sectors in unemployment



(1) The series were smoothed by moving-average procedure to remove seasonality.
 (2) Two industry groups were merged into 'Market services' for this graph.
 Source: Eurostat and own calculations.

Graph A.4: Deviation of sectors' share in vacancies from their share in unemployment, 2001-2013 (smoothed)



(1) Positive values are an indication of excess demand for labour in a particular sector and vice versa.

(2) The series were smoothed by moving-average procedure to remove seasonality.

Source: Eurostat, OECD, and own calculations.

Graph A.5: Alternative sectoral mismatch indicator



(1) The series were smoothed by moving-average procedure to remove seasonality.
 Source: Own calculations based on Eurostat data.

Appendix B: Constructing time series on job vacancy rates

OECD job vacancy statistics are available for longer time period but only for some EU Member States. Job Vacancy data are available from Eurostat for all countries, but time series span a short time period only.

In order to analyse the relation over time between vacancy rates and unemployment rates for all EU Member States, quarterly time series on job vacancy rates over the period 2000Q1-2013Q4 have been constructed integrating OECD and Eurostat statistics. In case of still short time series, the series are extended backward on the basis of the European Commission Business Survey (variable "*Factors limiting production: labour*").⁹ Table B1 reports country-specific information on sources on job vacancy statistics.

The final vacancies data cover the period 2000Q1-2013Q4 for all countries but Cyprus and Ireland, where availability of Business Survey limits the final sample to respectively 2001Q1-2013Q4 and 2009Q1-2013Q4.

The job vacancy rate is calculated following Eurostat definition:

Number of job vacancies*100 / (number of occupied posts + number of job vacancies)

Occupied posts are available from Eurostat for limited sample periods (Table B2). To obtain a proxy for occupied posts, a proportionality coefficient is computed as the ratio between occupied posts from Eurostat job vacancy statistics and employment based on Eurostat Labour Force Survey.¹⁰

Missing data for a number of countries have been proxied as follows

- For France occupied posts are not available from Eurostat database and the job vacancy rate is computed on the basis of total employment, LFS.
- For Italy, job vacancy rates are not available neither from Eurostat nor OECD. Hence, the job vacancy rate for the business economy published by ISTAT and available since 2004Q1 is expanded back to 2000Q1 on the basis of Business Survey data. The regression of the job vacancy rate on the factors limiting production gives an adj-R2 of 0.72 and a correlation between the fitted and the actual job vacancy rate of 85%.

⁹ A simple OLS regression yields a good fit with a correlation coefficient between the fitted and the actual vacancies higher than 50% for 11 countries and between 30% and 50% for 3 (survey data are used for 14 countries).

¹⁰ This coefficient averaged over time is applied to employment LFS figure to obtain an estimate of the occupied posts for the periods where Eurostat figures are missing.

Table B1 : Job vacancy series: country-specific information on sources

	Source	Availability	Indicator used to expand sample	Sector covered
Austria	OECD	2000Q1-2013Q4	:	Public and private sector
Belgium	OECD	2000Q1-2004Q1	EC Business Survey	Public and private sector
Bulgaria	Eurostat	2005Q1-2013Q4	EC Business Survey	2005q1-2008q4 NACE rev1 Industry and services (except public administration) 2009q1-2013q4 NACE rev 2 Business economy
Cyprus	Eurostat	2005Q1-2013Q4	EC Business Survey	2005q1-2009q4 NACE rev1 Industry and services (except public administration) 2010q1-2013q4 NACE rev 2 Business economy
Czech Republic	OECD	2000Q1-2013Q4	:	Public and private sector
Denmark	Eurostat	2010Q1-2013Q4	EC Business Survey	2010q1-2013q4 NACE rev2 Business economy
Germany	OECD	2000Q1-2012Q1	EC Business Survey	Public and private sector
Estonia	Eurostat	2005Q1-2008Q4	EC Business Survey	2005q1-2008q4 NACE rev1 Industry and services (except public administration)
Greece	Eurostat	2002Q4-2013q3	EC Business Survey	2002q4-2008q4 NACE rev1 Industry and services (except public administration) 2009q1-2013q4 NACE rev 2 Business economy
Spain	Eurostat	2001Q1-2013Q4	EC Business Survey	2001q1-2008q4 NACE rev1 Industry and services (except public administration) 2009q1-2013q4 NACE rev 2 Business economy (B-N); break in 2010Q1 (growth rate for 2010Q1 set to zero).
Finland	Eurostat	2000Q1-2013Q4	:	Public and private sector
France	OECD	2000Q1-2013Q4	:	Public and private sector, total new vacancies.
Hungary	OECD	2000Q1-2013Q4	:	Public and private sector
Ireland	Eurostat	2009Q1-2013Q4	:	2009q1-2013q4 NACE rev2 Business economy
Lithuania	Eurostat	2004Q1-2013Q4	EC Business Survey	2004q1-2008q4 NACE rev1 Industry and services (except public administration) 2009q1-2013q4 NACE rev 2 Business economy
Luxembourg	OECD	2000Q1-2013Q4	:	Public and private sector
Latvia	Eurostat	2005Q1-2013Q4	EC Business Survey	2005q1-2013q4 NACE rev 2 Business economy
The Netherlands	Eurostat	2001Q1-2013Q4	EC Business Survey	2001q1-2013q4 NACE rev 2 Business economy
Poland	OECD	2000Q1-2013Q4	:	Public and private sector
Portugal	OECD	2000Q1-2013Q4	:	Public and private sector
Romania	Eurostat	2005Q1-2012Q4	EC Business Survey	2005q1-2008q4 NACE rev1 Industry and services (except public administration) 2009q1-2013q4 NACE rev 2 Business economy
Sweden	OECD	2000Q1-2013Q4	:	Public and private sector
Slovenia	Eurostat	2001Q1-2013Q4	EC Business Survey	2001q1-2007q4 NACE rev1 Industry and services (except public administration) 2008q1-2013q4 NACE rev 2 Business economy
Slovakia	Eurostat	2004Q1-2013Q4	EC Business Survey	2004q1-2007q4 NACE rev1 Industry and services (except public administration) 2008q1-2013q4 NACE rev 2 Business economy
United Kingdom	OECD	2000Q1-2013Q4	:	Public and private sector

Table B2 : Occupied posts: country-specific information, Eurostat

	Availability	Indicator used to expand sample	Sector covered
Austria	2004Q2-2005Q1 NACE rev1 2009Q1-2013Q4 NACE rev 2	Industry and services (except public administration) Business economy (sectors B-N)	
Belgium	2012q1-2013q4	NACE rev2 Business economy (sectors B-N)	
Bulgaria	2005Q1-2009Q3 2009Q4-2013Q4	NACE rev1 Industry and services (except public administration) NACE rev 2 Business economy (sectors B-N)	
Cyprus	2005q1-2009q4 2010q1-2013q4	NACE rev1 Industry and services (except public administration) NACE rev 2 Business economy (sectors B-N)	
Czech Republic	2005q1-2009q4 2010q1-2013q4	NACE rev1 Industry and services (except public administration) NACE rev 2 Business economy (sectors B-N)	
Denmark	2010q1-2013q4	NACE rev 2 Business economy (sectors B-N)	
Germany	2004q4, 2007q4 2010q4-2011q2, 2011q4-2012q1, 2012q3-2013q4 2006Q4-2007Q3 2008q1-2009q4; 2011q3, 2012q2	NACE rev1 Industry and services (except public administration) NACE rev2 Business economy (sectors B-N). For 2005Q4, the occupied posts are calculated from the job vacancy rate and job vacancies for the same NACE categories; Source Eurostat.	
Estonia	2005q1-2008q4 2009q1-2013q4	NACE rev1 Industry and services (except public administration) NACE rev 2 Business economy (sectors B-N)	
Greece	2004q1-2009q3 2009q4-2012q4	NACE rev1 Industry and services (except public administration) NACE rev 2 Business economy (sectors B-N)	
Spain	2001q1-2008q4 2009q1-2013q4	All NACE NACE rev 2 Industry, construction and services (except activities of households as employers and extra-territorial organisations and bodies)	
Finland	2002q1-2008q4 2009q1-2013q4	All NACE NACE rev 2 Industry, construction and services (except activities of households as employers and extra-territorial organisations and bodies)	
France		:	
Hungary	2009q1-2013q1	NACE rev 2 Business Economy	
Ireland	2009q1-2013q1	NACE rev 2 Industry, construction and services (except activities of households as employers and extra-territorial organisations and bodies)	
Lithuania	2004q1-2008q4 2009q1-2013q4	NACE rev1 Industry and services (except public administration) NACE rev 2 (sectors B-N)	
Luxembourg	2004q1-2008q4 2009q1-2013q4	NACE rev1 Industry and services (except public administration) NACE rev 2 Business economy (sectors B-N)	
Latvia	2005q1-2008q4 2009q1-2013q4	NACE rev1 Industry and services (except public administration) NACE rev 2 Business economy (sectors B-N)	
The Netherlands	2001q1-2013q4	NACE rev 2 Business economy (sectors B-N) (sectors B-N)	
Poland		:	
Portugal	2001q1-2007q4 2008q1-2013q4	NACE rev1 Industry and services (except public administration) NACE rev 2 Business economy (sectors B-N)	
Romania	2005q1-2008q4 2009q1-2013q4	NACE rev1 Industry and services (except public administration) NACE rev 2 (sectors B-N)	
Sweden	2005q1-2009q4 2010q1-2013q4	NACE rev1 Industry and services (except public administration) NACE rev 2 (sectors B-N)	
Slovenia	2001q1-2008q4 2009q1-2013q4	NACE rev1 Industry and services (except public administration) NACE rev 2 (sectors B-N)	
Slovakia	2001q1-2008q4 2009q1-2013q4	NACE rev1 Industry and services (except public administration) NACE rev 2 (sectors B-N)	
United Kingdom	2001q2-2013q3	NACE rev 2 Business economy (sectors B-N)	

Appendix C: Computing job finding and separation rates

Data on job finding and separation rates throughout the paper are obtained adapting at quarterly frequency the approach developed by Elsby et al. (2013) on annual data. The computations of Elsby et al. (2013) are based on the procedure proposed by Shimer (2012) to estimate monthly job finding and separation rates correcting for the time-aggregation bias inherent to direct survey replies on unemployment duration arising from the fact that transitions in the labour market occur continuously, while labour force surveys are normally available in discrete intervals and not at high frequencies.

The probability that an unemployed worker exits unemployment within d months is obtained from the information on the duration of unemployment as follows:

$$F_t^{<d} = 1 - \frac{u_{t+d} - u_t^{<d}}{u_t}, \quad (\text{C.1})$$

where u_t is the number of unemployed at time t , and the superscript “ $<d$ ” denotes the number of unemployed at time $t + d$ that have entered unemployment between t and $t + d$. Assuming a Poisson distribution for the event of finding a job in a given time period, the hazard rate associated with the probability in (5) is given by $f_t^{<d} = -\frac{\log(1 - F_t^{<d})}{d}$. Such a hazard rate is the job finding rate, i.e., which approximates the probability of finding a job in a small time interval. The finding rate is computed for each duration available in Eurostat LFS sources, namely “less than one month”, “between 1 and 3 months”, “between 6 and 12 months”, “more than 12 months”. The average quarterly finding rate is computed as the weighted average of the different finding rates with weights chosen according to the optimality criteria described in Elsby et al. (2013).

To compute the separation rate an analogous approach to that for finding rates is not possible due to lack of data on duration of employment. Hence, separation rates need to be computed indirectly, using the evolution of unemployment over time $\dot{u}_t = s_t(1 - u_t) - f_t$, where the change of unemployment, \dot{u}_t , equals the difference between inflows into unemployment and outflows out of unemployment. Solving the equation above for u_t gives the path followed by the unemployment rate towards the flow steady state. Assuming that u_t and s_t are constant within quarters, the adjustment path followed by the unemployment rate towards the flow steady state can be expressed as

$$u_t = \lambda_t u_t^* + (1 - \lambda_t) u_{t-3}, \quad (\text{C.2})$$

where $u_t^* = \frac{s_t}{s_t + f_t}$ denotes the unemployment rate that equates inflow into unemployment with outflows out of unemployment and $\lambda_t = 1 - e^{-1(s_t + f_t)}$ is the quarterly rate at which unemployment rate converges toward the flow steady state u_t^* . The separation rate s_t can be obtained solving the non-linear equation (C.2).

APPENDIX D: Measuring labour market mismatch across skills, sectors, regions

The construction of the Beveridge curve builds on the relationship between vacancies and unemployment, and permits to identify growing mismatch whenever vacancies and unemployment increase together, on aggregate. Such an aggregate representation of the labour market does not take into account that the labour market is made of heterogenous segments, so that the same amount of vacancies could be associated with higher unemployment exactly because the distribution of vacancies that are open do not fit the distribution of the unemployed in terms of skills, industry, or geographical location.

With a view to provide synthetic, time varying measures of heterogeneity, mismatch indicators (MI) have been computed to capture the changing composition of labour demand and supply across education levels, sectors, and regions.

The sectoral mismatch indicator is defined as the sum over sectors of the absolute deviation between the share of a sector in total vacancies and its share in total unemployment (a similar indicator is built, e.g, in Lazear and Spetzler, 2012). To take into account differences in the size of sectors, the deviations are weighted by the sectors' share in employment. The sectoral mismatch indicator can thus be computed as:

$$\text{Sectoral MI} = \sum_{i=1}^I e_i |v_i - u_i|,$$

where i is an index for sectors (the total number of sectors is I), and e_i , v_i , and u_i are the share in employment, vacancies and unemployment of sector i . The value of the indicator is low if sectors that shed many workers also post many vacancies. If instead the composition of unemployment and that of vacancies is very different (so that sectors with a high share of unemployment have a low share of vacancies open, and vice-versa), the value of the indicator is high, indicating a high degree of mismatch. Data on sectoral employment, unemployment and vacancies was obtained from the Eurostat Labour Force Survey (LFS). Sectors were consolidated into five categories: (1) Industry (except construction); (2) Construction; (3) Trade, Transportation and storage, Accommodation and food service activities; (4) Finance, Real estate activities, and other services; and (5) Public administration and community services. (Agriculture was disregarded.) The methodological change caused by the revision of sectoral definitions in NACE (occurring in Q1 of 2008 for most countries in our sample) did not appear to affect the mismatch indicators.

The same indicator cannot be constructed to capture mismatch across skills, as vacancy rates differentiated by education level are not available. Hence, in line with existing work (e.g., Estevao and Tsounta, 2011), the skill mismatch indicator is defined as the average absolute deviation between the share of education groups in employment and their share in the working age population. In contrast with Estevao and Tsounta (2011), where the indicator is a simple sum of squared deviations, the gap between the share of a given skill group in employment and in the population is weighted with the group's share in the population. The skill-mismatch indicator is thus computed as:

$$\text{Skill MI} = \sum_{i=1}^3 q_i |q_i - n_i|,$$

where q_i and n_i are respectively the share of individuals with skill level i in the population and in employment. The indicator is low if the skill composition of the employed reflects the population's skill composition, while the indicator is high if the education groups that are highly represented in the population are not in terms of employment, and *vice versa*. Skill groups are defined based on educational attainment: low skills are defined as pre-primary, primary and lower secondary education (ISCED levels 0-2), medium skills as upper secondary and post-secondary non-tertiary education (levels 3 and 4), while high skills are defined as tertiary education (levels 5 and 6). Data were taken from Eurostat LFS. Structural breaks caused by changes in national LFS methodology have been corrected for. Thus, the indicator captures skills' imbalances between the potential labour supply and the labour demand and, as such, differs from a measure based on the comparison between the actual labour supply (the labour force) and employment by skill levels (e.g ECB, 2012).

As for the regional mismatch, the indicator used is relatively simpler. It is defined as the coefficient of variation of unemployment across regions:

$$\text{Regional MI} = \frac{\sqrt{\sum_{i=1}^R (u_i - \bar{u})^2 / R}}{\sum_{i=1}^R u_i / R},$$

where i in this case denotes regions, R is the total number of regions in the economy, u_i is the unemployment rate in region i and \bar{u} is the unemployment rate in the whole country. While common trends are visible in most countries for what concerns the distribution of labour supply across industries or skill categories (e.g., growing relevance of services, falling share of unskilled labour in working age population), no such trends need to be taken into account for the construction of a regional mismatch indicator, which can therefore be built without

major loss on the basis of unemployment rates only. A growing dispersion of unemployment would imply, other things equal, a type of unemployment that becomes more difficult to be matched with the existing mass of vacancies because it has become more heterogeneous from a geographical viewpoint. Data on the regional dispersion of unemployment rates is available from Eurostat LFS.

Since the sectoral mismatch indicator described above is not available for all EU countries for lack of sectoral vacancy data, an alternative sectoral mismatch indicator was computed to the analogy of the regional indicator: the coefficient of variation of unemployment across sectors. The calculation of this indicator is made possible by Eurostat's breakdown of unemployment by sector of last employment.