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Solving the Wage Puzzle: Does the "Non-Employment Index" Explain European Wage Dynamics Since the Global Financial Crisis

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Solving the Wage Puzzle: Does the "Non-Employment Index" Explain European Wage Dynamics Since the Global Financial Crisis?*

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Abstract

Contrary to the predictions of the traditional Phillips curve model, the euro-area experienced subdued wage growth despite a tightening labour market during the period 2013 to 2017. This has led to a debate around whether the standard unemployment rate, or indeed currently used broader measures, adequately capture the level of labour slack in an economy. In this paper, we construct a measure of labour market slack for twelve European countries, the Non-Employment Index (NEI). The NEI weighs each group outside the labour force by their relative probability of transitioning into employment. Using pseudo out-of-sample conditional forecasts, we show that the NEI is a better predictor of wage dynamics during the period 2013-2017 than other traditional measures of slack in countries exposed to the european sovereign debt crisis. The improvement is seen both in terms of point and density forecasts. We confirm this result in a panel framework, controlling for expectations, external factors, and productivity.

JEL Classification: J21,J30, J21, E37

*The opinions expressed in this paper are those of the authors and do not necessarily represent the views of the Central Bank of Ireland, the European System of Central Banks or the ECB. This research was carried out as part of the ECB's Expert Group on Low Wages (WEG) and a Box outlining a summary of the work is contained in Nickel *et al*, 2019. We thank Agustin Benetrix, Reamonn Lydon, Gerard O'Reilly, John FitzGerald, the members of the WEG, seminar participants at the 2019 Congress of the European Economics Association, the Irish Economics Association Conference 2019, and participants in the Central Bank and Trinity College Dublin seminar series for helpful comments that greatly improved the paper. All remaining errors are our own.

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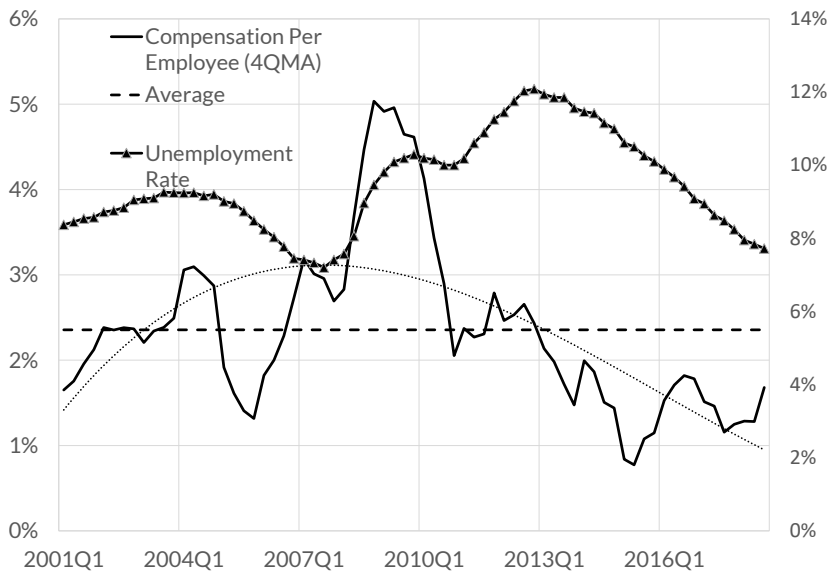
1 Introduction

A puzzling fact of the growth experience in the euro area during 2012 to 2017 is that wage growth remained consistently lower than forecast. This is despite a notable fall in the unemployment rate and other standard measures of labour market slack since 2013 (Figure 1). This phenomenon is puzzling because the wage phillips curve documents an inverse relationship between the degree of labour market slack and the pace of wage growth. In search and matching models of the labour market, wages are set in negotiations where the bargaining power of workers depends on the tightness of the labour market. In this framework, a tighter labour market implies greater bargaining power for the employees meaning they can demand higher wages.[1]

Figure 1: Euro Area Compensation Per Employee and Unemployment



Source: Eurostat and Authors' Calculations.

This episode has raised questions about whether slack in the labour market is accurately measured. Recent studies such as Bell and Blanchflower (2018) and Blanchard (2018) have asked whether accounting for those outside of the labour force may give us

[1] The propogation mechanism for this is typically through the wages of new hires in the Diamond (1982) Mortenson (1982) and Pissarides (1990) framework (see Lydon and Lozej, 2018)

a better understanding of the availability of labour and hence a more accurate view of the relative bargaining power of workers.

In this paper, we seek to answer this question in two steps. First, we construct a non-employment index (NEI) for a group of euro-area countries in the spirit of Hornstein, Kudlyak & Lange (2014). These authors constructed a NEI for the US labour market. The non-employed are the group of individuals who are not in employment, but do not meet the strict definition of unemployed as set out by the official statistical agencies. The ILO define "the unemployed" as persons of working age who were: a) without work during the reference period; b) currently available for work; and c) seeking work, i.e. had taken specific steps in a specified recent period to seek paid employment or self-employment. Second, we show that the constructed NEI outperforms other traditional measures of labour market slack in a conditional forecast comparison exercise in the countries affected by the european sovereign debt crisis. We argue that currently used indicators of labour market slack such as the unemployment rate, unemployment gap, and even more recently established broader measures such as "U6" can misrepresent the "true" level of slack available in a particular economy. Only a subset of workers who are outside of the labour force workers are comparable with the unemployed, which may under-represent the "true" level of slack. Brandolini, Cipollone and Viviano (2006) find that these are individuals whose last search effort dates back to no more than 6 months before the reference period.

There was a significant increase in discouraged workers in Europe during and after the global financial crisis. This is due to workers becoming discouraged and exiting the labour force after prolonged employment searches. As the labour market improves, these workers represent an additional pool of slack available to firms, reducing the wage bargaining power of incumbent workers. We show that, particularly in the countries worst hit by the european sovereign debt crisis, the missing wage growth is explained when the Phillips curve is respecified to account for this additional pool of non-employed workers.

Understanding the drivers of wage developments is of considerable importance in assessing the appropriate stance of monetary policy. Labour represents a significant frac-

tion of costs in most industries, hence wage growth is one of the primary drivers of consumer price inflation. Accordingly, there has been considerable research into this puzzle in recent times. Many have questioned whether the the phillips curve is still relevent (Blanchard, 2018; Moretti, Onorante and Zakipour-Saber,2019, Leduc and Wilson, 2017; Murphy, 2018). Some have suggested the possibility that the phillips curve may be non-linear (Byrne and Zekaite, 2018; Sin-Yu and Njindan Iyke, 2018,). Many papers have suggested that the unemployment rate is not a comprehensive enough indicator of the pool of available labour.

The paper that is most closely related to ours is that of Bell and Blanchflower (2018) who develop an underemployment index and show that underemployment in the UK and US labour markets is resulting in a flattening of the wage phillips curve. Underemployed workers are those who would like to work more hours. We go further and suggest that all those who are not working represent, with heterogeneous probability, individuals who could transition into employment in the next quarter. To do this, we use the methodology of Hornstein, Kudlyak and Lange (2014) who have developed a "non-employment index" for the US.

While the work to explicitly estimate a non-employment index is recent, it follows on a large body of previous research that points to the importance of considering job seekers who are outside of the labour force as well as the unemployed when analysing the labour market. Recent policy work such as ECB (2017) assessed developments in wider measures of labour market slack in comparison with the narrow definition of the unemployment rate. Blanchard (2018) also argued that if some workers become less employable or become discouraged, then the unemployment statistics will fail to capture hysteresis effects fully, because many of these workers will drop out of the labour force.

Our paper also contributes to the rapidly expanding literature on the importance of accounting for heterogeneous job searchers (Hall and Schulhofer-Wohl (2017), Ahn & Hamilton (2016)). In the context of estimating matching efficiency of the labour market, Veracierto (2011), Diamond (2013) and Elsby, Hobijn, and Sahin (2013) show that it is important to account for the job seekers out of the labour force in addition to the unem-

ployed. Hornstein & Lange (2016) motivated this in a theoretical framework, by estimating a model where they introduce endogenous search effort into the standard matching function of Diamond, Mortenson and Pissardes with job seeker heterogeneity.

The structure of the rest of the paper is as follows. Section 2 details the data sources used in our empirical analysis. In section 3 we document the calculation of the NEI - using the case of Ireland as an illustrative example. Section 4 discusses the heterogeneous dynamics in the non-employment indices across Europe. Section 5 details the conditional forecasting performance of our measure relative to other measures of slack traditionally used in estimating the phillips curve, while section 6 concludes.

2 Data

The analysis in this paper is based on data from the Labour Force Survey (LFS) which is a large-scale, harmonised survey of households carried out by each member state of the European Union. It is designed to produce quarterly labour force estimates that include the official measure of employment and unemployment on a consistent basis set down by the International Labour Organisation (ILO). In most countries, one fifth of the households in the survey are replaced each quarter. The longitudinal nature of the LFS makes it possible to track the labour market status of individuals over consecutive quarters during which they remain in the survey sample. This detailed information on worker flows allows us to calculate the probability of workers moving between different states, i.e. from unemployment to employment or from inactivity to unemployment, and these probability weights are used in constructing our non-employment index. This data is primarily available from the European Statistical Agency, Eurostat. We also gathered additional data from national central banks of the eurosystem, as data on transition probabilities are available only back to 2011 in the publically available dataset. [2]. This allowed us to compile the series back as far as 2005 for a selection of countries. One regrettable shortcoming of this work is the lack of availability of data for Germany. Longitudinal data from

[2]This exercise was carried out as part of the authors' work on the European Central Bank's Expert Group on Low Wages

the German Labour Force survey was not available from Eurostat or the Federal Employment Agency. Accordingly, Germany are excluded from the analysis.

3 The Non-Employment Index

The financial crisis of 2008-2012 had a severe and lasting effect on the European labour market (Table 1). The headline unemployment rate - which peaked at 12.1 per cent in the 1st quarter of 2013 for the euro area and 11.5 per cent for the EU28 - is a commonly cited measure of the impact of the crisis. However, this captures only part of the effect of the economic downturn on the labour market. As well as the workers who lost their jobs, a large number also exited the labour force entirely, particularly in the countries which were worst hit by the crisis in the periphery. Among those who dropped out of the labour force, some returned to education or training, while a significant number became discouraged as the recession persisted and stopped searching for work. In Ireland, one of the countries which was worst affected by the crisis, the overall labour force participation rate declined by four percentage points from Q4 2007 to Q4 2012 while the size of the inactive population - i.e. those neither employed or unemployed - increased by 13 per cent. Given the size of the pool of these non-employed individuals, a broader measure of labour utilisation than the standard unemployment rate may be needed to provide a fuller picture of labour market conditions.

A number of extended, or broader, measures of unemployment are published by statistical agencies such as Eurostat which include some individuals not usually counted as unemployed. The primary example of this is the "U6" measure, which has been widely used in the US and in Europe. These include passive job seekers, discouraged workers, students and individuals who report that they do not want a job. However, a key characteristic of these broader measures of unemployment is that they assign the *same weight* to all non-employed individuals outside the labour force. As a result, they do not take into account the substantial differences in the degree of labour force attachment of different types of individuals. For instance, looking at the transition rates of non-employed

Table 1: Peak to trough percentage point change in standard measures of labour slack (2008-2013)

	Unemployment Rate	Labour Force Participation
Austria	1.2	-1.6
Belgium	1.3	-1
Cyprus	8.2	-0.9
Spain	16.6	-2.5
Finland	2	-1.5
France	2.4	-1
Ireland	10.5	-4.5
Italy	4.6	-1.5
Lithuania	13.5	-3.9
Latvia	13.4	-1.8
Netherlands	2.1	-2.3
Portugal	7	-0.5
Slovenia	4.5	-1.5
Slovakia	4.9	-1.1

individuals who move back into work shows, unsurprisingly, that those who state that they are actively looking for work consistently have a much higher transition rate to employment than individuals who report that they are not engaged in job search.

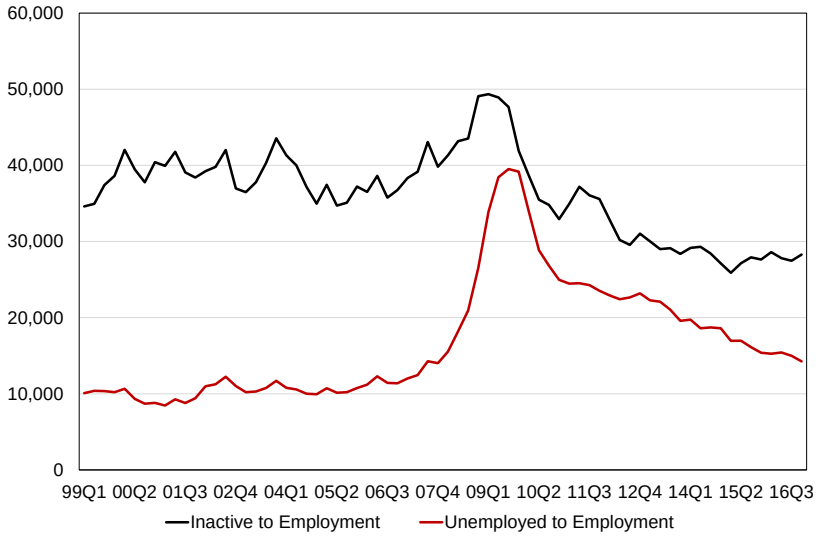
This section shows how the NEI accounts for this by using the transition probablities of each cohort as a proxy for labour force attachment. The Labour Force comprises the population aged 15-74 who are either employed or unemployed. However, the unemployed are only a subset of the working age population who are not in work (hereafter non-employed). The definition of unemployment is based on the notion that the individual 'seeks work'. Seeking work, however, is not a clear-cut process and the job search process of different individuals will have varying degrees of intensity depending on their circumstances. Every individual not currently working has some non-zero probability of transitioning into employment in the next quarter, and this probability reflects their attachment to the labour force.

The LFS splits the non-employed into five different cohorts: short-term unemployed; long-term unemployed; available not seeking; seeking not immediately available; and others. The stock and proportion of individuals in each cohort in each country is described in Table 2.

Between 2008Q4 and 2012Q4, the number of persons in the inactive group (i.e. outside of the labour force but not classified as unemployed) grew significantly in each of the countries considered, particularly in countries worst affected by the crisis - Ireland, Spain, Portugal, Italy and Greece.

An examination of the flows into employment reveals another reason to consider a broader measure of labour utilisation than the standard unemployment rate. For example, the flows into employment in Ireland from unemployment and inactivity in each quarter are shown in Figure 2. As the chart shows, the flow of workers from inactivity into employment every quarter is significantly larger than the flow of workers from unemployment back to employment. The probability that an individual from each of these non-employed or inactive cohorts transitions into employment in the following quarter serves as a proxy for each of these cohorts' attachment to the labour force.

Figure 2: Flows into Employment (Ireland)



Source: Eurostat and Authors' Calculations.

The average transition probabilities are described in Table 2. short-term unemployed persons had the highest transition probability over the sample period in all countries. Interestingly, those who are *seeking but not immediately available* in many cases have an

Table 2: Transition probabilities

	short-term	long-term	available not seeking	seeking not immediately available	Others
Austria	32.00	14.50	14.67	9.33	4.67
Cyprus	23.33	9.67	5.00	25.83	1.33
Finland	28.33	13.33	8.67	14.67	6.00
France	26.67	13.17	7.17	10.50	2.17
Italy	19.65	10.30	12.79	7.55	3.45
Latvia	23.00	12.67	8.00	8.83	3.33
Lithuania	17.67	8.17	3.50	0.00	1.83
Netherlands	25.33	13.67	5.67	9.33	3.33
Ireland	18.50	8.00	6.50	8.50	3.00
Portugal	24.17	15.17	9.50	6.00	5.00
Slovakia	9.08	4.06	7.28	4.87	0.99
Slovenia	23.83	14.83	8.67	7.00	6.50
Spain	22.83	9.33	5.17	8.67	2.67

Source: Eurostat, National Central Banks, and Authors' calculations.

average transition probability greater than those who are classified as long-term unemployed. This category comprises individuals who have been actively seeking work in the previous four weeks but are not available in the next two weeks. Those who are not seeking because they are in education or training have an average transition probability of 8 per cent. Overall, the ranking of the employment probabilities in Table 1 is closely aligned with individual's self-reported desire to work as recorded in the LFS: those actively seeking work have a higher transition probability than those who want work but are not searching for a job. In Austria, Cyprus, Finland, Italy, Ireland and Slovakia, at least one of the cohorts outside of the labour force have significantly higher transition probabilities than the long-term unemployed. This feature of the data suggests that the unemployment rate may not fully capture the degree of slack in the labour market.

To address this potential under-estimation of slack, we propose the non-employment index which takes into account differences in the labour market attachment of non-employed groups. Our methodology follows closely that of Hornstein *et al.* (2014) who were the

first to develop a NEI for the United States. The NEI is a weighted average of the population shares of the cohorts outlined in Table 1, where the weights for each cohort is given by that group's average transition probability to employment over the labour force survey (Table 2). This index gives a measure of the available units of labour in the economy. We assign a weight of 1 to the short-term unemployed, who have the highest transition probability, and assign each of the other cohorts' weight relative to this. To take a concrete example, Irish individuals who are classified as *seeking but not immediately available* have an average probability of transitioning into employment over the sample of 10.98 per cent. In the same country, the average transition probability of someone who is short-term unemployed is 18.5 per cent. Combining these probabilities, the *seeking not immediately available* cohort are are given a weight of $\frac{8.5}{18.5} = 0.46$. In each quarter in our sample, the stock of workers in each cohort is reweighted using this method. More formally, the non-employment index for each period t is defined as:

$$\sum_{j=1}^{9} \theta_j \frac{Pop_j}{Pop}$$

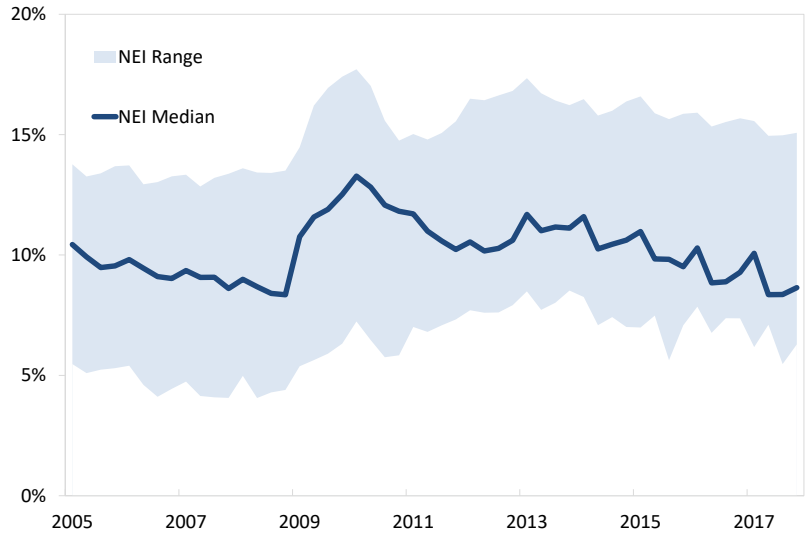
where we multiply the population share of cohort j by their transition probability defined weight θ from Table 2. This yields the non-employment rate as a percentage of the *working age population*. The key contribution of the NEI is that each cohort is now weighted according to their probability of transitioning into employment. As a result, the NEI may represent a more accurate picture of slack remaining in a given economy since other measures of labour market slack do not account for these heterogeneous transition probabilities.

One caveat is that our measure still does not account for slack which is available in terms of workers coming from abroad, who may transition into employment from unemployment in a different region. This group represent a further source of slack, which may be more important in terms of the wage phillips curve when the labour market is tight. Obviously, this is also the case with more standard measures of labour market slack, but further work to incorporate this dimension would be a valuable contribution.

4 Non-Employment Indices for Europe

Figure 3 shows our estimates of the median Non-Employment Index (NEI) for the 13 countries in our sample. The shaded bands represent the highest and lowest NEI in the sample at any given time.

Figure 3: Non-Employment Range



Source: Eurostat, National Central Banks and Authors' Calculations.
Note: The blue line represents the median of the cross country NEI

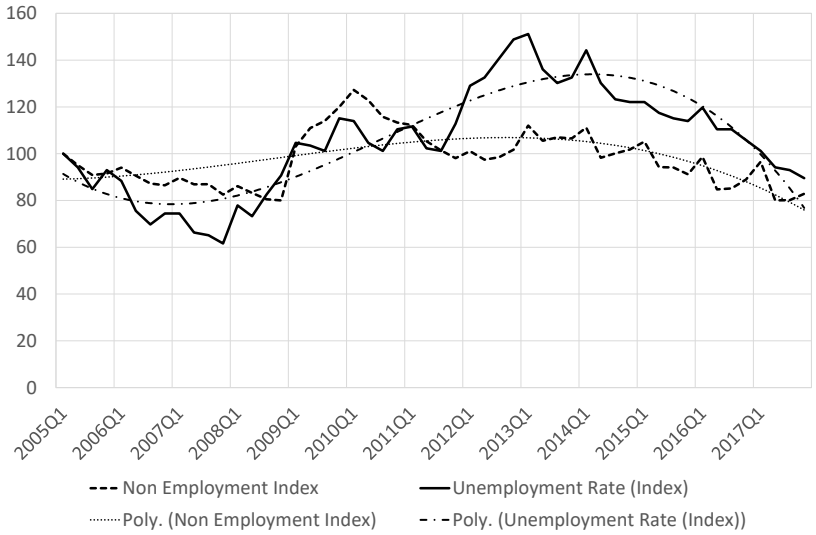
What is more important to our analysis however is the additional information that the NEI gives the researcher compared with the standard unemployment rate. It is important to note that different denominators are used in the calculation of the NEI and the standard unemployment rate. As such, they are not directly comparable - the NEI is calculated as a percentage of the *working age population* while the unemployment rate is expressed as a share of the *labour force*. In figure 4, we index both the median non-employment index and the median unemployment rate to 2005Q1, the beginning of our sample, in order to compare the dynamics in both series.

It is clear that during the post crisis period (2013 to 2017) the slope of the unemployment rate is much steeper than that of the non-employment index. Both series in-

crease substantially during the crisis, but the pace of the subsequent decline in the Non-employment series is much slower than that of the unemployment rate.

Figure 4: Non-Employment and Unemployment Indices

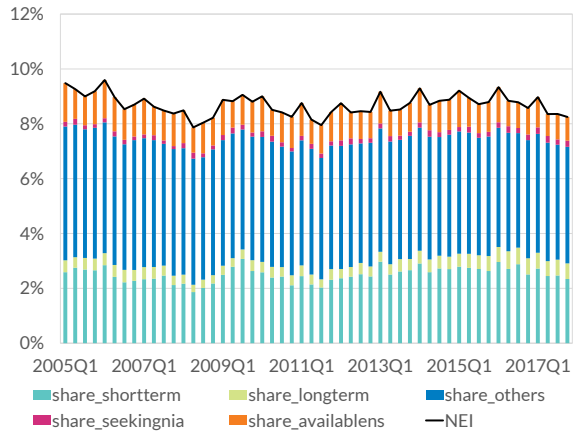
Dashed lines represent cubic trends



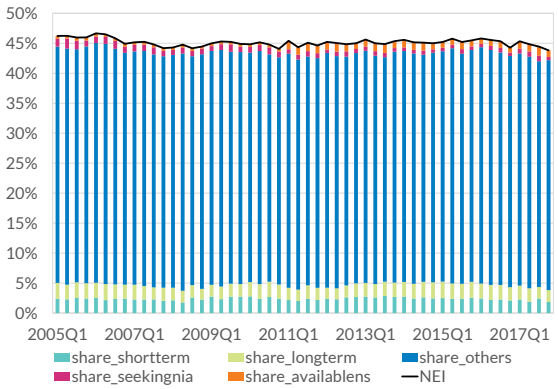
Source: Eurostat and Authors' Calculations.

There is substantial heterogeneity across countries in terms of the level and dynamics in non-employment, which is driven both by the structure of their respective labour markets and by the degree to which countries were hit by the european sovereign debt crisis between 2008 and 2013. Figure 5 that within these groups however, the NEI in certain countries was driven to a greater or lesser extent by movements in the cohorts outside of the labour force. In crisis-hit countries, there was a significant increase in the number of individuals who were *available but not seeking*. Portugal, for instance saw the number *available but not seeking* increase significantly after 2011. While the number of short and long-term unemployed has decreased, these discouraged workers remained outside of the labour force and, as such, kept their NEI higher than would have otherwise been the case. This was also the case in Italy, where those who are identified as "available but not seeking" have a higher transition probability (and hence weighting) than the long-term unemployed.

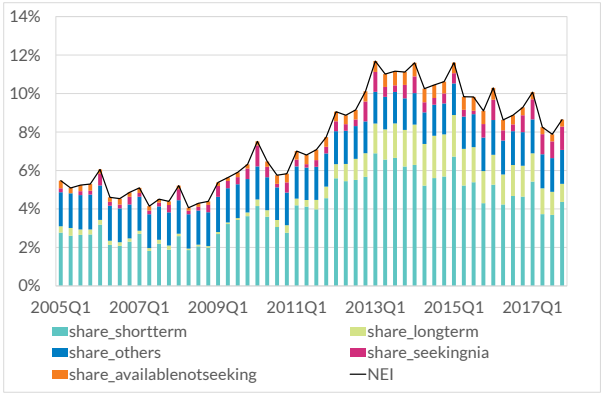
Figure 5: NEI Decompositions



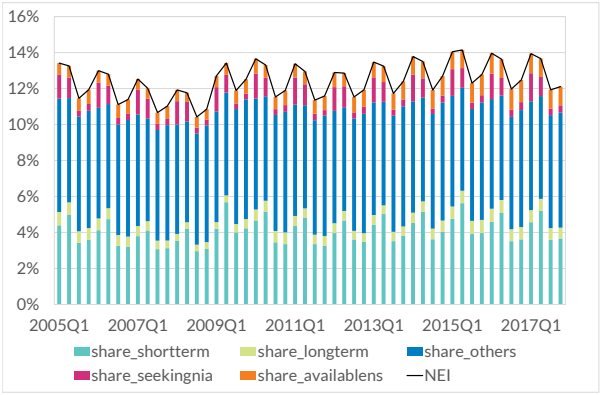
Austria



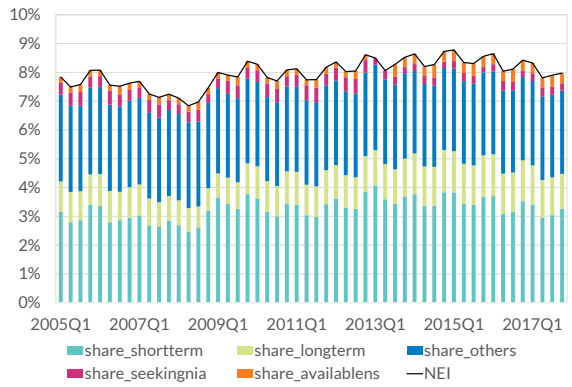
Belgium



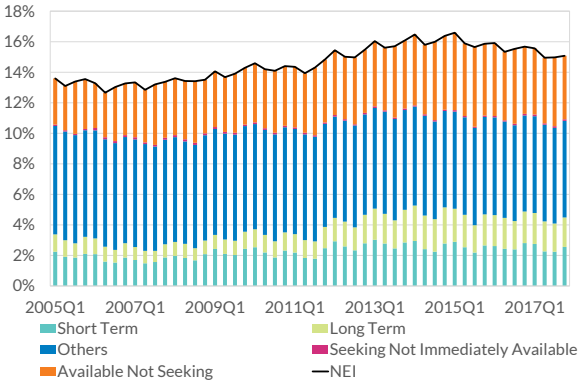
Cyprus



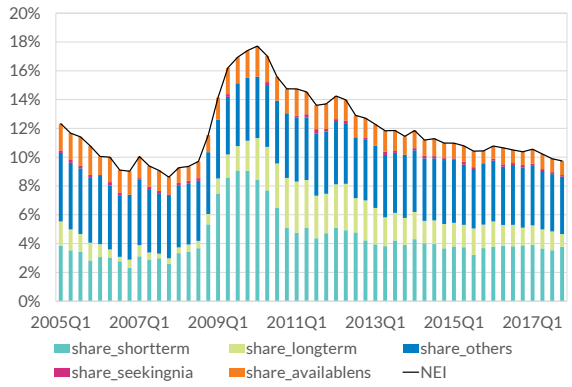
Finland



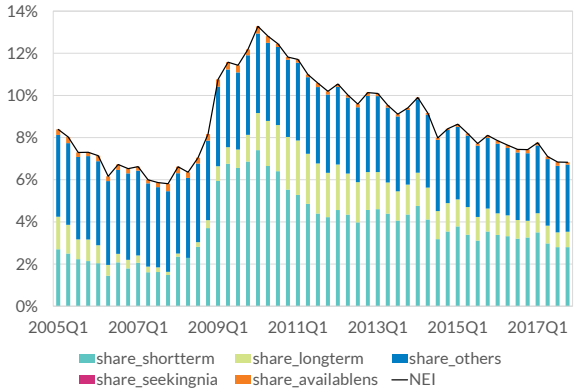
France



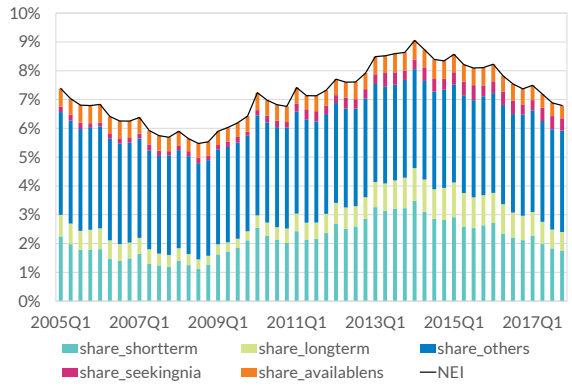
Italy



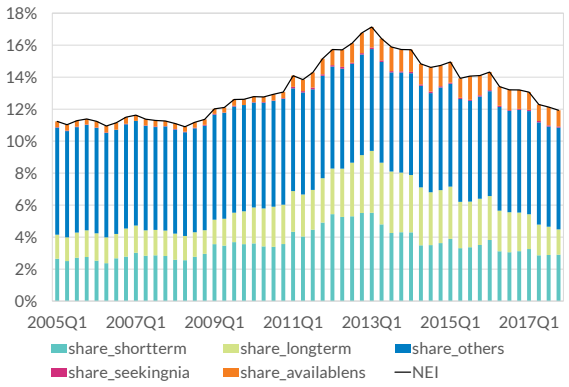
Latvia



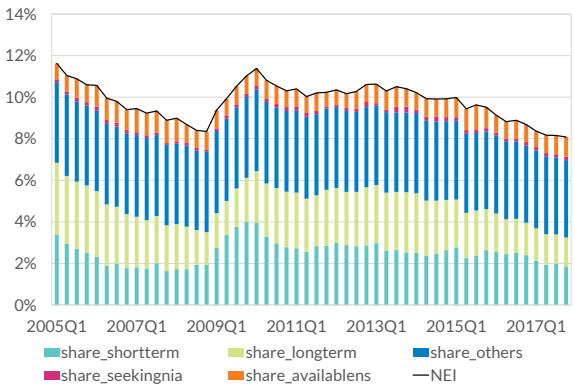
Lithuania



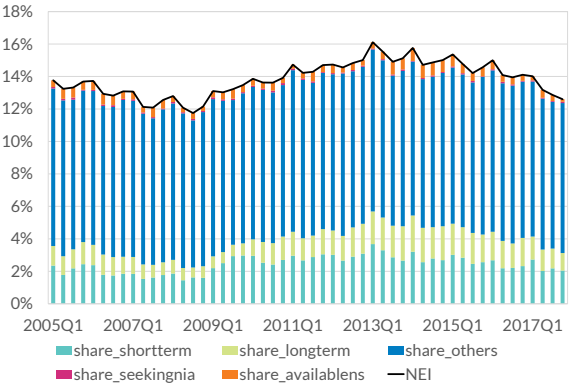
Netherlands



Portugal

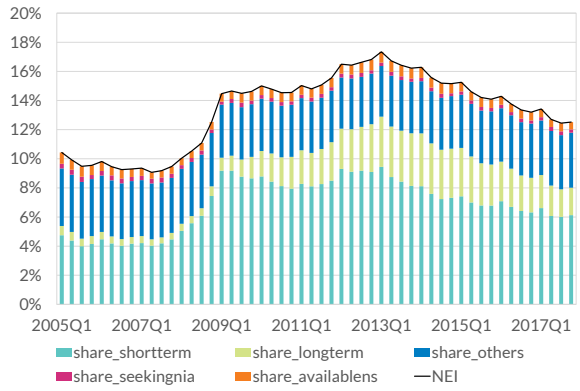


Slovakia

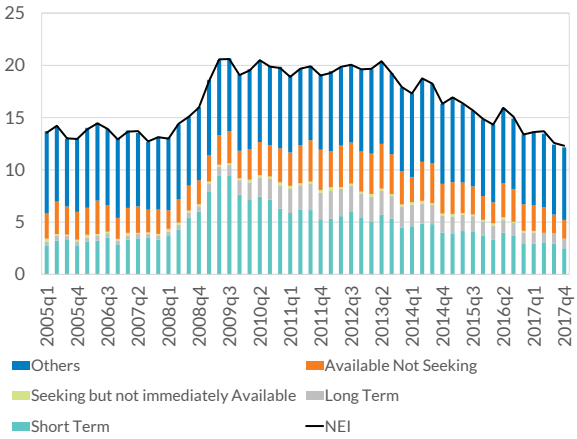


Slovenia

NEI Decompositions



Spain



Ireland

The non-employment index can also capture the way in which the standard unemployment rate can *overstate* the available pool of labour. In Spain for instance, the long-term unemployment rate expanded significantly in the wake of the great recession and has remained stubbornly high. Through the lens of the non-employment rate however, one can see that this pool of labour, when weighted by their attachment to the labour force, is lower than might be believed from an analysis of the standard unemployment rate. This is because the Spanish long-term unemployed have a very low transition probability relative to the short term unemployed, meaning that their weight in the NEI is lower. Specifically, 9 per cent of those classified as long-term unemployed transition back into employment each quarter, whereas 22.8 per cent of those who are short term unemployed make the same transition. The non-employment index properly accounts for this by assigning a weight of 0.41 to the stock of long-term unemployed in Spain.

There are structural differences in each country's labour market that result in these idiosynacrasies. An example would be the incentive structures around the timing of unemployment benefits. This means that in certain countries individuals are less incentivised to remain in the labour force. For example, in Italy, Austria and Slovakia the long-term unemployed actually have a lower transition probability than the *available not seeking*. In Finland, Ireland, Poland and Sweden the long-term unemployed have a lower transition probability than those who are *seeking not immediately available*.

These differences may also arise out of differences in the measurement of those cohorts outside the labour market. For instance, those who are classified as *seeking not immediately available* are likely classified as such for heterogeneous reasons. The ILO definition of "unemployed" requires the individual to be available to start work within the next two weeks. This would mean that a person who was seeking work, but going on a holiday for two weeks, would not be classed as unemployed.

It is also likely that, despite the harmonised nature of the LFS, that there are country specific idiosyncrasies in the classification of different groups. For example, if an individual answering the survey in April is partaking in a course of study but wishes to take a job when the course breaks for summer in June they are more likely to be *seeking not immediately available*. If they do not break for summer, or if they plan to use the break for recuperation, they would likely be classified in "others".

5 Empirical Analysis: The NEI and Wage Dynamics

We have so far shown that the standard unemployment rate could give an underestimate of the potential available slack in the labour market. This has important implications for Central Banks, for whom the relationship between wages and slack forms an important part of the monetary policy decision making toolkit. In this section, we test whether including the non-employment index as the measure of the available level of labour market slack in a country's phillips curve improves wage projections in a pseudo out-of-sample wage forecast.

The traditional phillips curve denotes the relationship between nominal wage growth (π_t) and labour market slack (x_t)

$$\pi_t = \alpha + \delta \, \mathrm{E} \, x\_1 + \epsilon_t \tag{1}$$

where α is a constant representing the long run rate of wage growth, and $_t$ is a measure of slack in each time period. Our aim is to test whether our measure of slack, the NEI, outperforms the other measures in forecasting wage growth after the crisis.

Table 3: Wage and Slack Measures Used

Slack Measure	**Source**
Unemployment Rate	Eurostat
Unemployment Gap	Deviation of Unemployment from NAIRU (authors' calculations)
Output Gap	European Commission
U6	Eurostat
Non-employment Index	Eurostat, National Central Banks and Authors' calculations
Wage Measure	**Source**
Compensation Per Employee	Eurostat
Hourly Earnings	Eurostat
Unit Labour Costs	Eurostat

To test this, we use a framework that allows us to compare wage forecasts using traditional measures of labour market slack with the new NEI measure.

5.1 The model

We estimate a two-variable vector autoregression (VAR) to capture the relationship between each measure of slack and wage growth in each country between 2005Q1 and 2013Q4. We then conduct conditional forecasts of wage growth for the period 2014Q1 to 2017Q4, where the forecasts are conditional on the realised outturn of each slack measure over the forecast period. We estimate this equation for four alternative measures of slack and for three wage measures outlined in table 3. In total, for each wage measure there are five separate VAR models estimated for each country.

The VAR takes the following form:

$$\begin{pmatrix} x_t \\ wg_t \end{pmatrix} = C + B_1 \begin{pmatrix} x_{t-1} \\ wg_{t-1} \end{pmatrix} + ... + B_p \begin{pmatrix} x_{t-p} \\ wg_{t-p} \end{pmatrix} + \varepsilon_t,\ \varepsilon_t \sim N(0, \Omega). \qquad (2)$$

where the vector x_t and wg_t represent the measure of slack and wage growth, respectively. The vector $C = (c_x, c_{wg})'$ contains the intercepts, $B_1, ..., B_P$ are 2×2 coefficient matrices, p denotes the lag length and the reduced form residuals $\mu_t = (\mu_t^x, \mu_t^{wg})'$. Ω denotes the residual variance-covariance matrix. The estimation and conditional forecasts

of the model are generated with Bayesian methods. We adopt a Minnesota type prior as per Blake and Mumtaz (2012). This choice is consistent with the high persistence of euro area slack measures. Another advantage of our estimation strategy is that the use of Bayesian methods allows us to account for estimation uncertainty arising from the relatively short sample period.

The VAR conditional forecasts of wages are based on paths formed from the actual realizations of the selected slack measure. We use the method of Waggoner and Zha (1998) that generates predictive distributions from the VAR conditional on the path of the slack variable. The deviation between the conditional and unconditional forecasts is used as a source of information for deriving the conditional forecasts for the VAR errors over the forecasting sample. The distribution of conditional forecasts of wage growth is retrieved by iterating the VAR forward with draws of the residuals.

5.2 Estimation Results

We rank the forecast accuracy of each slack measure using the root-mean-squared errors (RMSE) of the conditional forecasts. The lower the RMSE, the more accurate the forecast of the wage measure, conditional on the outturns of the particular measure of slack over the projection period (2014Q1-2017Q4).

A summary of the results are outlined in Table 4. The first row of each of the panels outlines RMSE for the full sample, and we present the results for the three wage measures used in our estimation. Hourly earnings is a the most "pure" measure of changes in wages, in that it is not affected by changes in the number of employees. Compensation per employee and unit labour costs are both ratios which can be driven by dynamics in the number of employees and the level of output.

Table 4 shows that the NEI outperforms each of the other measures in the crisis countries when hourly earnings or unit labour costs are used as the measure of wage inflation. For compensation per employee, it is ranked second in the crisis countries and third in the overall sample. The reason for this is likely that the dynamics in compensation per employee are driven to a large extent by increases in hours worked. When workers increase

their hours, aggregate wages increase but the wage of the individual worker does not.

As discussed in section 2, the additional benefit of the NEI particularly applies to countries that have been hit by an adverse labour market shock. Countries where the unemployment rate is very high, typically see large flows of workers out of the labour force and into inactivity as a result of becoming discouraged. If this is the case, we expect that countries' which were worst hit by the eurozone sovereign debt crisis, had larger numbers of individuals move out of the labour force due to discouragement and skills mismatch, etc.

To illustrate this, we restrict the sample to the crisis-hit countries in our sample (Italy, Ireland, Portugal, Spain and Cyprus) in the second row of each panel. Again, for the hourly earnings measure, the non-employment index outperforms the unemployment rate on average, as well as the unemployment gap and other standard measures.

Table 4: Forecast Comparison: RMSEs of conditional forecasts 2014Q1-2017Q3

Hourly Earnings					
	Unemployment Rate (SA)	Output Gap	NEI	U6	UGap
Crisis Countries	2.690	2.115	**1.743**	1.792	2.117
Overall	2.696	2.186	**1.75**	1.866	2.218
Compensation Per Employee					
	Unemployment Rate (SA)	Output Gap	NEI	U6	UGap
Crisis Countries	1.858	1.573	1.848	1.776	1.745
Overall	1.867	1.538	1.405	1.590	1.398
Unit Labour Costs					
	Unemployment Rate (SA)	Output Gap	NEI	U6	UGap
Crisis Countries	3.684	3.887	3.503	5.464	4.133
Overall	2.778	2.815	2.733	3.976	3.147

5.3 Forecast Distribution

While the point estimates show only the results in terms of forecast accuracy, our modelling approach also allows us to consider whether using broader measures of slack such as the NEI yields improvements in terms of forecast certainty. To illustrate this point, Figure 8 plots the median forecast, along with the 16th and 84th percentile of the forecast

distribution and compare this to the outturn of the respective wage measure in the Irish case. The NEI is the only slack measure for which the wage forecast remains within the bands throughout the entire out-of-sample forecast period. To test this empirically by computing the log densities of the forecast distributions for each model. The log densities yield a measure of forecast certainty. The results of this estimation are outlined in Table 5, and the NEI performs well. For hourly earnings, the conditional forecasts from the models estimated using the NEI have the lowest density, this is also the case for Unit labour costs. In the case of compensation per employee, the output gap appears to perform marginally better. We speculate that this is related to the output gap capturing to some extent the "non-wage" component of compensation per employee in the short run, e.g. the rate of employment growth.

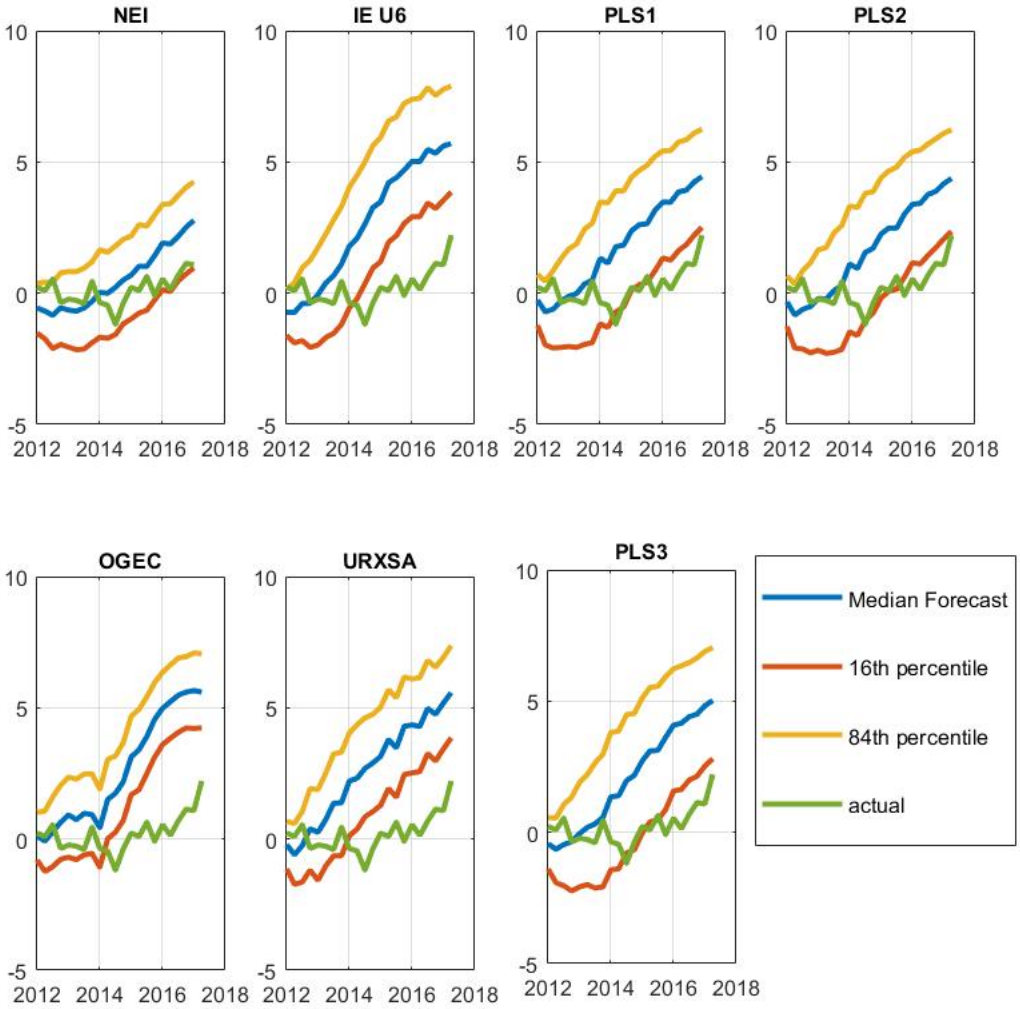
Table 5: Conditional Forecasts: Log Density Scores

		Hourly Earnings			
	URXSA	OGEC	NEI	U6	UGAP
Crisis	-2.597	-2.163	**-2.073**	-2.133	-2.364
Overall	-2.577	-2.197	**-2.025**	-2.101	-2.394
		Compensation Per Employee			
	URXSA	OGEC	NEI	U6	UGAP
Crisis	-3.473	**-1.927**	-1.998	-2.142	-2.122
Overall	-2.635	**-1.801**	-2.129	-1.821	-1.800
		Unit Labour Costs			
	URXSA	OGEC	NEI	U6	UGAP
Crisis	**-3.548**	-6.879	-3.694	-7.290	-6.141
Overall	**-2.679**	-4.516	-2.823	-4.946	-4.185

5.4 Panel Analysis

The analysis thus far demonstrates that the NEI outperforms other measures of slack in explaining the missing wage puzzle, particularly in crisis-hit countries. However, it could be the case that the parsimonious specification used to isolate the relative performance of each of the slack measures misses important dynamics. For example, productivity

Figure 8: Forecast Horserace: Ireland



and a proxy for inflation expectations are typically included in a standard phillips curve framework. To investigate the performance of the NEI in this regard, we estimate an augmented version of the standard wage phillips curve akin to the theoretical work of Gali (2011) and the empirical work of Bonam et al(2018) and Bulligan and Viviano (2017). We estimate a specification which regresses wages, $w_i t$, on a measure of slack $S_i t$, lagged nominal wage growth, and lagged consumer price inflation, π_t^e as a proxy for expected inflation:

$$w_{it} = \alpha_{it} + S_{it-1} + w_{it-1} + \pi_{it-1} + \mu_{it} \tag{3}$$

Lagged wage growth captures persistence in wage dynamics, whereas lagged consumer price inflation captures foward looking behaviour in wage setting. The model is estimated using the fixed-effects estimator with robust standard errors clustered at the country level. Table 6 outlines the results. In the baseline specification, we only include the non-employment index as our measure of slack and lagged compensation. In the second specification, we include lagged consumer price inflation to capture expectations[3]. In the third specification, we add a measure of productivity, output per worker, and the coefficient on non-employment remains largely unchanged. Under all specifications, including with lagged wages as a proxy for inflation expectations, the NEI remains a statistically and economically significant predictor of wage developments. Finally, we test each of these specifications with the unemployment rate as our measure of slack. In all cases the sign and statistical significance of the result is the same, however the magnitude of the coefficient on the NEI is statistically significantly larger than that on the unemployment rate.

[3]we test various lags of inflation, the results do not change significantly

Table 6: Panel Regression

	Baseline	Productivity	Inflation	Unemployment
NEI_{t-1}	-0.281***	-0.331***	-0.321***	
	(0.061)	(0.079)	(0.072)	
CPE_{t-1}	0.984***	0.978***	0.971***	0.965***
	(0.003)	(0.004)	(0.009)	(0.011)
$hicp_{t-1}$		-0.107***	-0.0964***	-0.0840**
		(0.028)	(0.028)	(0.032)
$Prod_{t-1}$			0.0227	0.0436
			(0.023)	(0.029)
$Unemp_{t-1}$				-0.157***
				(0.044)
Constant	6.317***	7.812***	6.143***	1.497
	(1.031)	(1.451)	(1.213)	(1.751)
Observations	510	510	510	663
R-squared	0.985	0.985	0.986	0.986
Number of panelid	10	10	10	13

[1] Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

6 Conclusion

We generate a new measure of labour market tightness for a selection of euro area countries. We show that the non-employment rate accounts well for the rather subdued wage dynamics evident in the euro-area during the recent expansion. Our analysis shows that policymakers should focus both on the stock of workers who are outside the labour force, but also their probability of transitioning into employment. The non-employment index has been slower to decline, and indeed remains elevated in many countries in contrast to the unemployment rate. This is particularly the case in the countries which were worst hit by the european sovereign debt crisis in 2009-2011. As the crisis persisted, large numbers of workers became discouraged, or otherwise marginally attached to the labour force. During the recovery, this additional pool of labour reduces the bargaining power of workers, placing downward pressure on wages. Our analysis shows that after a cyclical downturn non-employment could be a valuable addition to the policymakers toolkit when examining the level of available slack in the labour market.

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