

**NAIRU and Okun's Law –
The Macro-Economy in a Nutshell?**

Final report

Thematic Paper for the
European Commission
Directorate General for Employment, Social Affairs and Equal Opportunities

written as part of the
European Employment Observatory

by
Luisa Stock
Kurt Vogler-Ludwig

Munich, 22 June 2010

Contents

1.	Introduction.....	4
2.	NAIRU - the non-accelerating inflation rate of unemployment.....	5
2.1.	Theoretical Framework	5
2.2.	Estimation approaches	8
2.3.	Estimation results	10
2.4.	Critical views.....	18
3.	Okun's Law	19
3.1.	Theoretical Framework	19
3.2.	Okun's Law: original and expanded version.....	19
3.3.	Estimation approaches	20
3.4.	Estimation results	21
3.5.	Critical views.....	27
4.	Empirical application of approaches.....	28
5.	Assessment of approaches and conclusions	35
	Annex	39
	Literature	46

Tables

Table 1	Sacrifice ratio	13
Table 2	Standard errors of OECD NAIRU estimates	13
Table 3	NAIRU estimates (1990-1999) by Mc Marrow and Roeger (2000)	15
Table 4	Comparison of estimation results for the time-varying NAIRU	16
Table 5	Estimation results for the time-varying NAIRU by Stephanides (2006)	17
Table 6	OLS estimations for Okun's coefficient by Moosa (1997)	22
Table 7	Basic statistics for rolling OLS estimations by Moosa (1997)	22
Table 8	Lee's estimation of Okun's coefficient	23
Table 9	Okun's coefficient by Sögner and Stiassny (2002)	25
Table 10	Impact of output growth on labour force and employment by Sögner and Stiassny (2002)	25
Table 11	Overview of Okun's coefficient by studies	27
Table 12	Estimation results for the time varying NAIRU	44
Table 13	Real GDP growth and change of unemployment rate by country	45

Charts

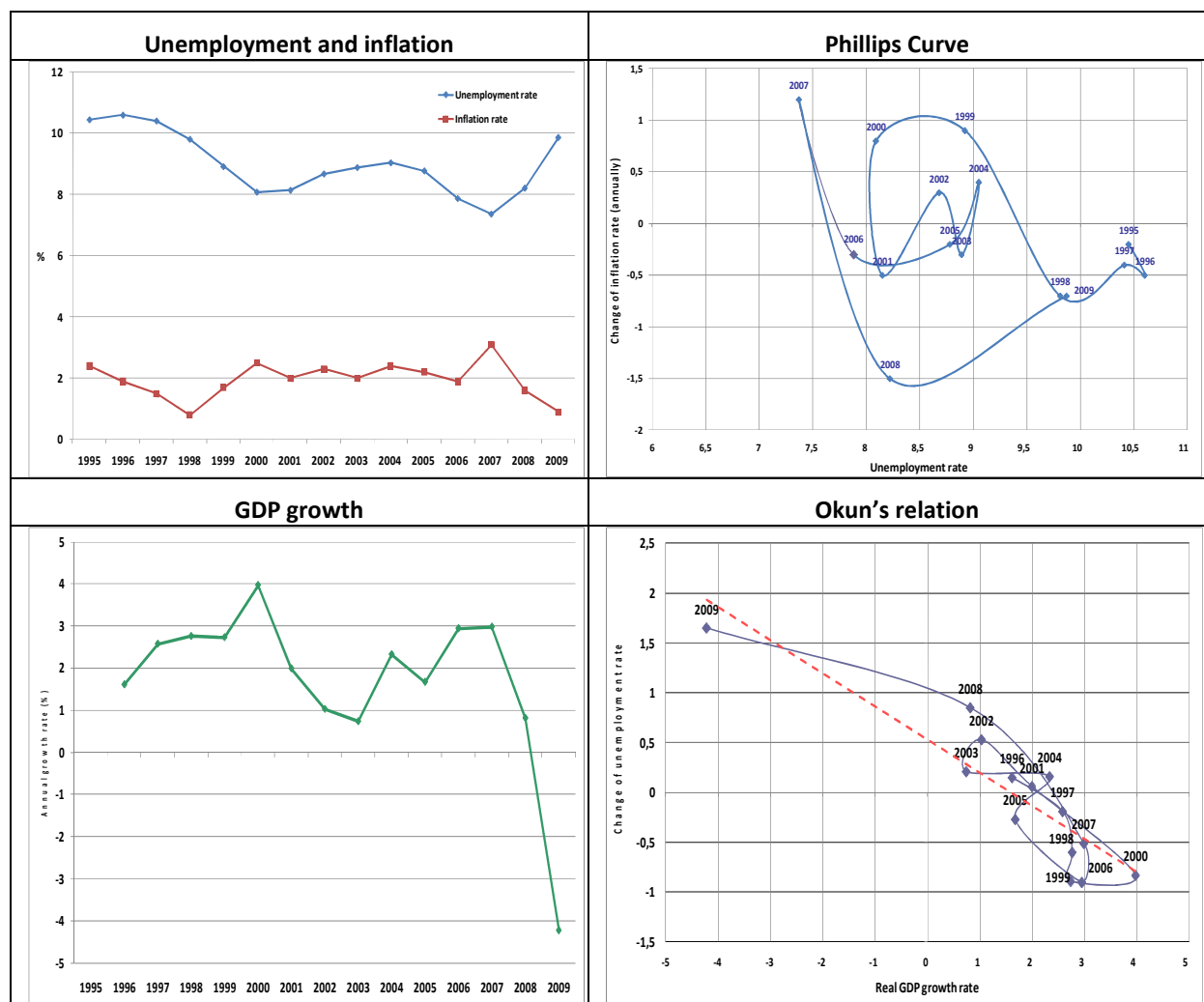
Chart 1	Growth, unemployment and inflation in the Euro area	4
Chart 2	Equilibrium unemployment rate	6
Chart 3	NAIRU for six EU countries	12
Chart 4	90 % confidence intervals by Mc Marrow and Roeger, estimates for 1999	16
Chart 5	Estimates of time-variant and constant NAIRU	17
Chart 6	The relationship between output and unemployment	26
Chart 7	GDP growth and change of unemployment rates for selected OECD countries*	29
Chart 8	Variation of GDP growth and the change of unemployment rates for 21 OECD countries	30
Chart 9	NAIRU, unemployment rate and inflation rate by country	33
Chart 10	NAIRU and long-term unemployment rate by country	34

1. Introduction

Growth, inflation and unemployment are the great themes of macro-economic theories and the major targets of economic policies. These phenomena have always been a reason for great debates, and well-known concepts like the Phillips Curve, the NAIRU or Okun's Law have been developed to explain their linkages. Their origin lies in statistical observations which revealed negative correlations between inflation and unemployment (the Phillips Curve) or growth and unemployment (Okun's Law). The statistical evidence initiated numerous publications which today fill libraries rather than bookshelves.

If we look at the outcome, however, things remain weird. The Phillips Curve for the Euro area for example did not follow the theoretically suggested concave function during the last 15 years. In reality it looks like a series of leapfrogs rather than a stable relationship (Chart 1). There were periods of declining unemployment without a change of inflation (1995 to 1998 or 2004 to 2006) and periods of rising unemployment and rising inflation (2001 to 2004 and 2008 to 2009). The times compatible with the theory are the exceptions rather than the norm (1998 to 1999 and 2006 to 2008). Okun's Law showed a more stable relationship between GDP growth and the change of unemployment rates, even if there are also periods with adverse reactions. Most importantly, however, the trend function does not appear to be time invariant. The recent crisis demonstrates that unemployment reacted much less to the GDP's exceptional decline than during the years before. Past experience was unable to foresee the impact of policy interventions and the new role of human capital in modern economies.

Chart 1 Growth, unemployment and inflation in the Euro area



Source: European Central Bank, Economix

In spite of the tremendous research efforts in this area, its impact on the real economy has remained limited. Unemployment has not disappeared in any of the Western economies and particularly not in Europe. Not more than a gradual decline of unemployment rates has been achieved, and the recent crisis pushed it back to the former top levels. The combat against unemployment is thus still the major problem in the European Union and the question how it could be removed remains open.

Considering this critique of the traditional Phillips Curve approach, this article is going to assess two measurement approaches which use unemployment as a key indicator for macro-economic development. The NAIRU (non-accelerating inflation rate of unemployment) identifies an equilibrium point where both inflation and unemployment are stable. It does not really care at which level of inflation and unemployment this equilibrium emerges, but it describes the point where only systemic reforms can lead to a more favourable situation. The NAIRU is therefore taken as an indicator for the flexibility of product and labour markets.

Okun's Law is less ambitious regarding the theoretical background. It is the empirical relation between economic growth and unemployment which allows identifying the "break-even point" of growth above which unemployment can be expected to decrease. The indicator also measures systemic behaviour. It reflects the sensitivity of labour markets on growth fluctuations – demand shocks in particular. As it belongs to the traditional toolbox of macro-economics, this article concentrates on the question whether new empirical methods are better enabled to characterise the behaviour of the economy and of labour markets in particular.

Both indicators are strongly relevant for employment policies. The question is how they relate to other unemployment concepts like frictional¹, structural², or long-term unemployment³, and what they mean for employment and macro-economic policies. What is the operational value and theoretical meaning of the approaches and do they allow predicting the turning point of the labour markets? Is it possible to reduce the complexity of economic systems to one simple model or even a single equation? Do the NAIRU and Okun's Law show the economy in a nutshell?

The paper will present both concepts separately. For each indicator it will describe the theoretical background, review empirical evidence, and assess the quality of the indicators. Moreover their application for predictions especially in the context of the financial crisis will be examined. The evaluation will be undertaken from the viewpoint of labour market analysis rather than macro-economic research.

2. NAIRU - the non-accelerating inflation rate of unemployment

2.1. Theoretical Framework

Principal approach

The non-accelerating inflation rate of unemployment, shortly known as NAIRU, describes an equilibrium state of an economy in which unemployment does not cause inflation and vice versa. The model is based on the assumption that both wage and price changes depend on price expectations and unemployment. These drivers move the economy towards equilibrium where the inflation rate is stable and unemployment at its "natural" rate.⁴

The NAIRU has its theoretical and empirical roots in the theory of the Phillips Curve. This approach was first developed by Irving Fisher in his article on "A Statistical Relation between Unemployment and Price Changes" (Fisher 1926). A.W. Phillips revitalised the concept in 1958 when he found a negative correlation

¹ Frictional unemployment arises due to the time needed for the transition between jobs

² Structural unemployment is unemployment which is caused by a sustainable change of demand in particular economic sectors for example due to technological progress

³ Long-term unemployment comprises people which are unemployed for 12 month or longer

⁴ The theoretical framework can be found in Annex I. Another theoretical framework is presented by Gordon's "Triangle Model" which defines the dependency of the inflation rate on a triangle of factors, particularly the expected inflation, the unemployment gap as proxy for demand conditions and supply side shocks (Gordon 1997).

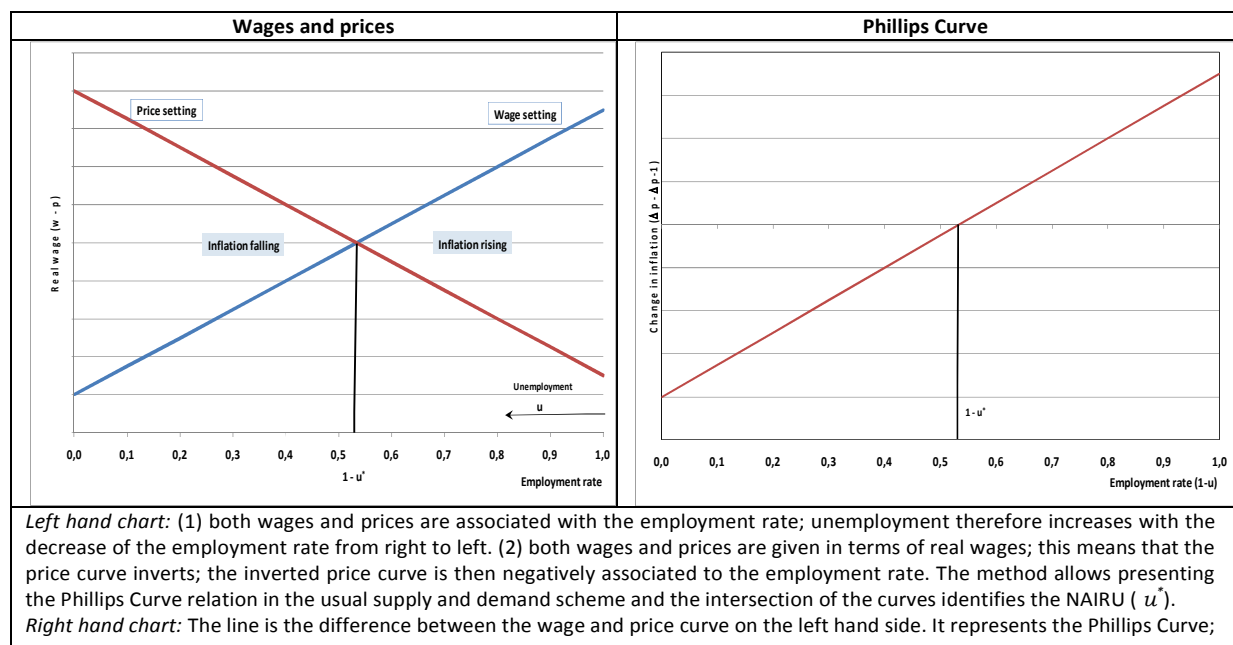
between the inflation rate and the unemployment rate with data from the UK for the years 1861 to 1957 (Phillips 1958). In the years following, Paul Samuelson and Robert Solow illustrated the same correlation for the US with data for the years 1900 to 1960 (Samuelson and Solow 1960). The economic coherence became known as the Phillips Curve, which says that low unemployment is associated with high inflation rates and vice versa. With a simple model and a clear message the Phillips Curve soon became a central module in macroeconomic theory and economic policy.

The validity of the correlation however dropped away in the curse of the oil crisis in the 1970s when inflation and unemployment rose simultaneously. A new correlation had to be found and was detected in the association between the unemployment rate and the change of the inflation rate. Expectations regarding the change of inflation became a core element of the approach which is known as expectation-augmented Phillips Curve (Blanchard and Illing 2004).

Starting with this context the NAIRU theory postulates that in the medium term the unemployment rate tends to return to an equilibrium level which is known as the natural rate of unemployment. This is based on assumptions for price and wage setting behaviour: prices are set relative to wages, wages are set relative to prices, and both depend on unemployment. This results in two log-linear functions which define the equilibrium between inflation and unemployment. Wages and prices above the equilibrium inflation rate tend to be reduced by rising unemployment and values below this rate lead the economy back with declining unemployment. This relation is shown in Chart 1 by a simplified model. Only if the unemployment rate corresponds to the equilibrium or natural rate of unemployment the inflation rate stays stable.

This economic behaviour of inflation is derived from a bargaining model. Wages are set in negotiations between employers and employees. The bargaining power of employees is higher if unemployment is low as workers don't fear job losses. Wage claims target at real wages and thus depend on both the unemployment rate and the expected price level. If prices increase the real wage falls. Thus, employees claim a wage increase which will at least compensate the expected price increase in order to hold real wages at a stable level.

Chart 2 **Equilibrium unemployment rate**



Source: Layard et al. 1991

The companies on the other hand set their prices with respect to cost developments. If higher wages are expected, companies will increase prices and vice versa. What appears to be clear for price levels is less

evident for the price mark up. There has been a considerable debate about the price setting behaviour of firms with conflicting results (Layard et al. 1991, p. 336). A general conclusion is that prices tend to be relatively unresponsive to changes in demand. For demonstration purposes, price mark ups are often assumed to decline with rising output levels – or declining unemployment.

Using these principal relations, the connection between unemployment and inflation can be described as:

$$\Delta p - \Delta p_{-1} = -\theta_1(u - u^*) \quad (1)$$

where Δp is inflation, Δp_{-1} is the inflation of the previous year, u the unemployment rate and u^* the natural unemployment rate. If the unemployment rate is below the natural rate of unemployment, the change of the inflation rate is positive, meaning inflation rises and vice versa. Inflation is only stable when the unemployment rate equals the natural unemployment rate. This equilibrium level defines the NAIRU.

Equation (1) is known as the expectation-augmented Phillips Curve because it introduced the dependency of inflation on price expectations. An adaptive expectation model is assumed where price expectations are determined by previous inflation. In the case of equation (1) price expectations are equal to previous inflation which is certainly a crude simplification of adaptive expectation processes. In other models distributed lags over a period of years are used to describe the adaptation more accurately.

Interpretation

In a direct understanding the NAIRU is the unemployment rate which is needed in order to keep inflation stable (Blanchard, Illing 2004, p. 249). This is almost a recommendation which tells economic policy the level of unemployment which – under given circumstances – is necessary for zero inflation. Authors however regularly allude to the uncertainties of the calculations.

The NAIRU is also interpreted as the borderline between cyclical⁵ and structural unemployment (Franz 1999, p. 2). While in the long-run the NAIRU measures the structural component, the difference between actual unemployment and the NAIRU represents the cyclical component. It measures the inflationary pressure which comes from demand shocks. An actual unemployment rate above the NAIRU allows combating unemployment by the expansion of aggregate demand without propelling inflation. Below this level, however, it is necessary to remove functional barriers on product and labour markets. Policy should raise competition and increase market flexibility in order to lead the economy back to a more balanced position regarding inflation and unemployment.

Following the second point, the NAIRU is interpreted as a hysteresis measure. Particularly in Europe, the long-term increase of the NAIRU has been understood as an indication of progressive sclerosis of labour markets. The feedback between inflation and unemployment weakened as a result of the steady rise of the “natural rate of unemployment”. This process is seen as the consequence of increasing long-term unemployment: as long-term unemployment is not considered in wage determination this leads to the growing power of insiders (Blanchard, Illing 2004, p. 672). Wages are determined by efficiency wage considerations rather than labour market imbalances and thus do not lead the labour market back to equilibrium. The research conclusion from this was the introduction of time variant NAIRU estimates. The policy conclusion was the liberalisation of labour markets and the activation of the unemployed.

Determinants

It is important to note that the NAIRU results from price and wage setting behaviour. Product markets and labour markets are therefore both relevant. In a perfect neoclassical world prices and wages are fully flexible and there is no inflation and no unemployment. This however is far from reality and the question arises why unemployment persists and why wages and prices appear to be sticky.

Wages are determined by different bargaining models which range between the free bargaining of workers and employers, collective bargaining systems to publicly controlled incomes policies. Empirical estimates of cross country differences in the NAIRU identified the generosity of unemployment insurance and the coverage of collective bargaining as major explanatory factors. Other determinants are legal rigidities

⁵ Cyclical unemployment relates to the cyclical trends in growth and production that occur within the business cycle

on labour markets and mismatch problems (Mc Marrow, Roeger 2000; Gianella et al. 2009). As far as this is true, the NAIRU appears to be the result of institutional regulations rather than the definition of the inflation/unemployment equilibrium. In this sense the NAIRU is the expression of a political compromise defined by a great number of government regulations, collective agreements, company based remuneration systems and individual behaviour.

Price setting depends on costs and market development. The NAIRU models usually assume a price mark up on costs (i.e. expected wages), which is constant or tends to change with the level of activity. Pricing behaviour, however, appears to be a highly controversial subject in economic theory. Empirical evidence is ambiguous: according to a European survey covering around 11,000 firms in the Euro area, mark-up pricing is the basic principle but price discrimination is applied broadly. About 80 % of firms set prices case-by-case rather than following a given cost-price relation. The study concludes that "... the model of perfect competition with the law of one price does not seem to be the blueprint for most of the goods and services markets in the Euro area". This weakens major assumptions of the NAIRU model, particularly the assumption of adaptive price setting behaviour, and "... suggests that models with monopolistic competition, like New Keynesian models, may be a better description for most goods and services markets than those that assume perfect competition." (Fabiani et al. 2005).

Hysteresis is one of the key words that are associated with the NAIRU approach. It characterises the fact that prices or wages are affected by short-run demand changes which appear to have long-term effects, as the forces to move the economy back to the long-term equilibrium are weak. This means that the economy is not – or rather is slowly – returning to its original state when the demand shock disappears. With wage and price stickiness, unemployment shifts to a new long-run equilibrium. In Europe this was often at a continuously higher level. The weakness of labour markets to return to full employment equilibrium is caused by the fact that the long-term unemployed are no full equivalent to the short-term unemployed, and the short-term unemployed are no full equivalent to the persons employed. The limited substitution among these groups reduces the effects of unemployment on wages and thus decelerates the adjustment process.

In the course of research, the distinction between a short and a long-run NAIRU was introduced⁶. This appeared to be striking as it separates short-term (demand) shocks from the long-term systemic structure of an economy, which is determined by institutional and behavioural parameters. The long-run NAIRU on one hand is defined as the equilibrium of unemployment with stable inflation and a stable unemployment rate. It depends on social and economic variables, such as benefit systems, wage bargaining arrangements or price regulation. The short-run NAIRU on the other hand is characterised only by the stability of inflation (Mc Marrow, Roeger 2000) and is affected by last year's events (short-term hysteresis). In practice, however, separating these two forms appears to be difficult. Particularly in Europe where a steady increase of the estimated NAIRU values could be observed, the distinction was not really helpful. Obviously there was an interaction between short-term and long-term NAIRU which made it difficult to isolate the two effects. This was the reason for introducing time-variant estimates for the NAIRU.

2.2. Estimation approaches

Since the NAIRU is an unobserved variable it needs to be estimated. A large number of different estimation methods have been applied which range from univariate time-series methods to various forms of wage-price models. The measures can be broadly grouped into three categories (Richardson et al. 2000, pp. 34-39):

- **Purely statistical techniques**, which split the unemployment rate into cyclical and trend components where the latter defines the NAIRU.
- **Structural methods**, which use equilibrium models with specified wage and price equations and estimate the long-term NAIRU as a time-invariant equilibrium.
- **Time-variant approaches** which are a combination of the two outlined methods. The NAIRU is then – similarly to the structural approach – estimated on the basis of equations explaining inflation, typically

⁶ A formal derivation of the long-run NAIRU is presented in Annex II.

based on the expectation-augmented Phillips Curve framework. In addition, the estimates use statistical techniques to impose restrictions on the pathway of the NAIRU or the unemployment gap between the actual rate of unemployment and the NAIRU. This method generates values for a time-varying NAIRU.

Purely statistical methods

The idea of a statistical approach is that unemployment consists of both a cyclical component and a trend component (the NAIRU). It is assumed that there is no trade-off between inflation and the unemployment rate in the long-term and that the actual unemployment rate fluctuates around the NAIRU. Several methods are used for the decomposition, such as the Beveridge-Nelson filter or the Hodrick-Prescott filter. These filters are based on assumptions which part of the variance has to be classified as cyclical or structural.

Several drawbacks of this method can be illustrated:

- The estimated indicators are poorly correlated to inflation
- The reliability of indicators decreases towards the end of the estimation period, which is the most relevant time frame for analysis
- A large number of filters behave like moving averages, which means that they perform poorly if large and sudden changes in unemployment rates occur
- It is often impossible to assess the accuracy of the results

The results therefore encumber a precise interpretation, and the methods have not been used in recent studies as better alternatives are available.

Structural methods

This method typically applies a system of equations for estimating the NAIRU. These equations explain the behaviour of wage and price-setting, as for example illustrated by Layard et al. (1991). According to these models, the equilibrium unemployment rate is attained when a stable inflation rate is compatible with the firms' and the workers' decisions regarding mark-ups on prices and wages. The estimated value corresponds to the long-term NAIRU.

In spite of the clear theoretical formulation of the model, the empirical application raises a series of questions which lead to disagreement among researchers:

- about long-term effects of real interest rates, taxation and productivity growth on real wages and equilibrium unemployment
- about the number and identification of explanatory variables
- about statistical identification concerning the estimation of the wage and price-setting curves.

The number of explanatory variables is very important as the results show high sensitivity to the subsets of variables. The application of the same specification is therefore needed for cross-country comparisons which – in parallel – limits the adaptation to country specificities. In theory all explanatory variables should be involved in both equations but this is difficult to apply for some countries (e.g. US).

Moreover, this method only generates a long-term equilibrium of the NAIRU assuming that the value is constant. The NAIRU has, however, changed over time as it has been affected by changes in institutions and has experienced shocks which have influenced both unemployment and inflation. Thus, an approach which estimates the NAIRU at different points in time has become more appropriate.

Time-variant approach

In recent studies this approach has been the most popular technique for calculating the NAIRU. A time-varying NAIRU means that the NAIRU is calculated for different points in time within the sample period. This allows labour market structures to be observed over a period of time. Nevertheless, this approach does not reveal which forces are driving the NAIRU.

The approach uses the expectation-augmented Phillips Curve as a theoretical framework. For making estimations a filter decomposition method is used – commonly the Kalman filter. This filter estimates the

correct status of an equation system from inaccurate data. Both the equation system and the error must be known. A particular advantage is that the equations are allowed to have time-varying parameters⁷. This allows the long-run NAIRU and short-run Phillips Curve to be estimated at the same time, without identifying all relevant variables specified in the theory (for example long-lasting shocks).

This method has important advantages over the other two methods (Richardson et al. 2000 p. 38):

- The underlying Phillips Curve can capture different specifications and thus provides a well-defined concept for estimation
- It is possible to distinguish between the short-run NAIRU and the NAIRU within the fully-specified Phillips Curve
- The relevant indicators can be produced timely and consistently across countries

Nevertheless, also this approach suffers drawbacks from the filtering methods:

- The estimated NAIRU relies on a reduced equation, meaning that the underlying structural relationships have not been identified. This makes it more difficult to derive the NAIRU, especially if only temporary supply shocks are incorporated in the Philips Curve estimation (Richardson 2000, p. 39)
- The relationship between unemployment and inflation needs to be stable and well defined over the whole estimation period as too little variation in the NAIRU causes misspecifications, while too much variation undermines the concept and makes the NAIRU of limited use (Stephanides 2006, p. 11)
- There is an inconsistency in the procedure as the transition equation implies full hysteresis which may or may not hold. The implementation of persistence in the transition equation, however, would be complicated; hence the literature accepts such an inconsistency (Franz 2003, p. 17).
- For the application of the Kalman filter initial conditions and smoothing parameters need to be determined (Franz 2003, p. 18)
- The NAIRU estimates are dependent on the specification of the Phillips Curve

2.3. Estimation results

In the last decade several studies have used the time-variant approach to estimate the NAIRU. For the following presentation we selected the most recent estimates for EU countries:⁸

- Gianella et al (2009) for 23 OECD countries
- Mc Marrow and Roeger (ECFIN) (2000) for the EU Member States
- Stephanides (2006) for the EU-15 countries, Japan and the US

Gianella et al. (2009) (OECD)

This is the most recent study estimating the time-varying NAIRU for 23 OECD countries, thereof 15 EU countries.⁹ Beside the time-varying NAIRU, Gianella et al. analyse the determinants of structural unemployment in a cross country comparison. A two-stage approach is applied: In the first stage the time-varying NAIRU is estimated for individual countries on the basis of the Phillips Curve relationship. In the second stage, the estimated NAIRUs are regressed on different institutional and policy variables by using panel estimation techniques. The estimation results are compared to a previous study by the OECD (Richardson et al. 2000)

First Stage:

To estimate the time-varying NAIRU a semi-structural approach is applied which uses the Philips Curve equations as a basis. This means that inflation is related to the unemployment gap which is the difference between the actual unemployment rate and the NAIRU. The time-varying NAIRU in this context is esti-

⁷ To use the Kalman filter, the system of equations has to be rewritten in "state space form" with a signal equation (Phillips Curve equation) and a transition equation which specifies the properties of the time varying NAIRU (Gianella 2009, p. 9). A further introduction to the Kalman filter is presented in Annex III.

⁸ Other estimates of time-varying NAIRUs are e.g. Fabiani and Mestre (2004) for the Euro Area and Orlandi and Pichelmann (2000) for the European Union.

⁹ These are Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, and the UK.

mated by using the Kalman filter. The derivation of the estimation equation and the Kalman filter is illustrated in more detail in Annex III.

Estimation results

The authors estimated the NAIRU for 23 OECD countries. The sample period varies by country, which depends on the availability of relevant data. The longest sample available was for Belgium over the period 1961 Q1 to 2007 Q4, while Portugal had the shortest sample period from 1980 Q1 to 2007 Q4.

The estimation results for the NAIRU are presented in Annex IV and are illustrated in Chart 3 for a selection of countries¹⁰ showing the different time paths since 1970.

In the UK the NAIRU reached a peak in the second half of the 1980s and then continuously decreased until the second half of this decade. This might be associated with the labour market reforms of the 80s which resulted in a more flexible labour market. Similarly in Spain a sharp drop of the NAIRU can be observed in the second half of the 1990s. This could also be a consequence of the increasing flexibility in the Spanish labour market. In the United States however, only minor changes can be observed which correspond with the time pattern in the UK.

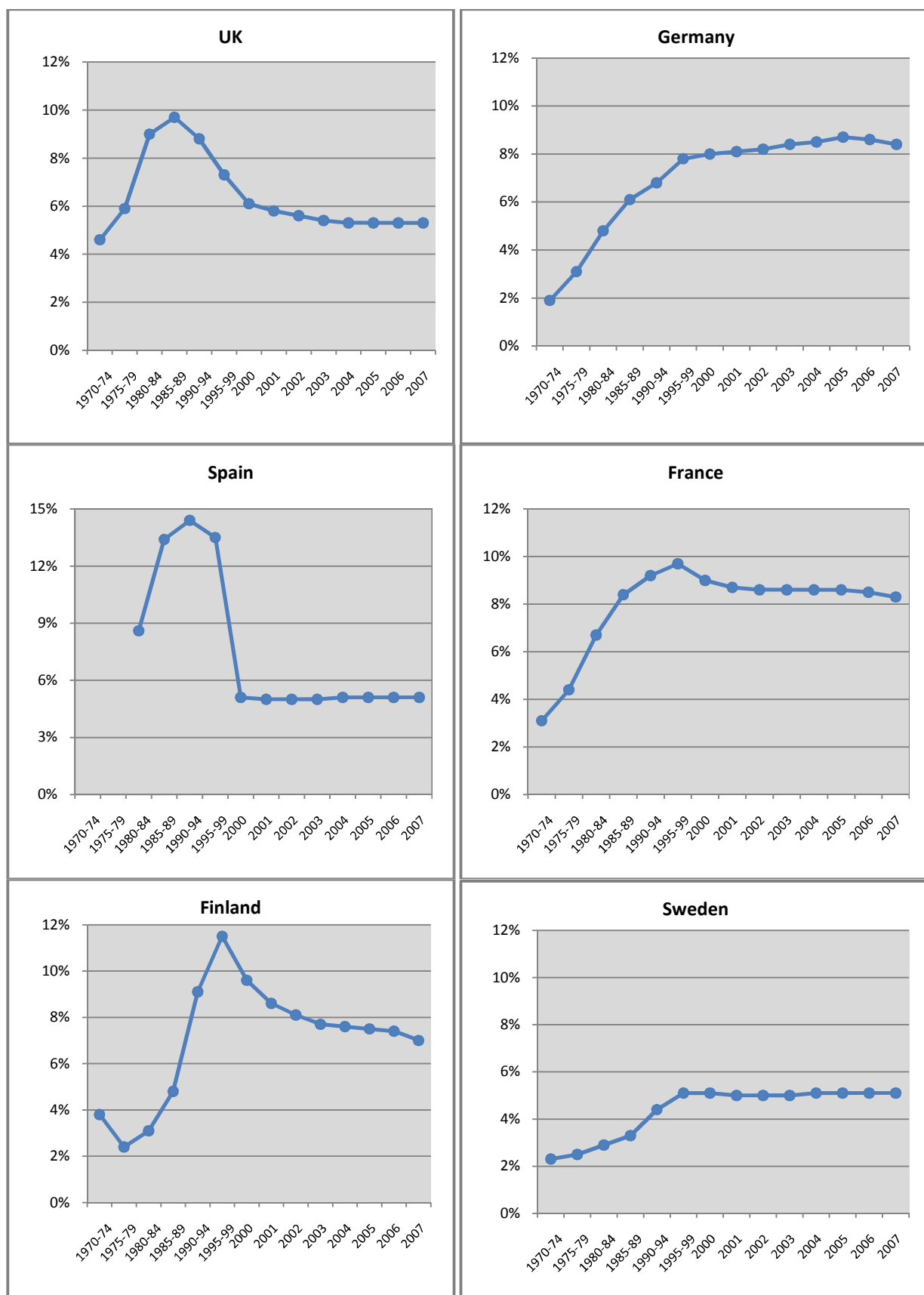
For Germany, on the other hand, a continuously increasing NAIRU was estimated for the longest part of the observation period. A slight decrease can however be seen at the end of the sample period when the German labour market reforms (Hartz reforms) slowly started to become visible. A similar development of the NAIRU is illustrated for France, showing a marginal decline of the NAIRU at the beginning of the 90s and at the end of the sample period.

For a long time Sweden had low unemployment rates, mainly because of the expansion of the public sector. This resulted in low NAIRU rates until the beginning of the 90s when the NAIRU increased due to the financial crisis. Since 2000 the NAIRU has remained more or less unchanged.

Finland shows a strong fluctuation of the NAIRU with a peak in the second half of the 1990s. Within two decades the NAIRU almost tripled. With the start of the new millennium a continuous decrease can be observed which, however, did not lead back to the low level of former periods.

The estimates show large differences between countries. Looking at the most recent year, 2007, the highest values between 8 % and 9 % are given for Greece, France, Germany and Belgium. Low levels are estimated for the Netherlands, Luxembourg, Denmark and Austria. Japan also has a low NAIRU for 2007. The profiles are similar to previous estimates (Richardson et al. (2000)). Some of the results are affected by revisions of unemployment data (Germany) or improved compatibility of the results with the historic profile (Belgium, Portugal and the UK).

¹⁰ The data for the other EU countries are included in Table 12 in Annex IV.

Chart 3 NAIRU for six EU countriesSource: Gianella et al (2009) p. 41, *Economix*

The estimation results reveal strong country-related differences regarding the relation between inflation and the unemployment gap. This is usually measured by the sacrifice ratio which shows how much output is lost if inflation decreases by 1 %. If the sacrifice ratio is high, countering inflation becomes more expensive (Cecchetti and Rich 1999). As Table 1 shows, the values range between 0.5 for Austria and 2.4 for Sweden. High values of around 2 % are also estimated for Finland, Belgium, Germany, Ireland, and the Netherlands. Low values appear in Austria, Luxembourg, Portugal, Greece and France. The results are close to those estimated by Richardson et al. (2000).

The estimation results point out that real import price inflation has a significant influence on domestic inflation in most of the countries, while the real oil price inflation is significant only in a few countries. All in all, the estimates of the NAIRU are relatively insensitive regarding the chosen inflation indicator.

Precision of estimates

The precision of estimates was checked with the help of Monte Carlo simulations. As a result, the coefficient of variation (the relation between the double average standard error in relation to the NAIRU) ranges between 8.7 % for Ireland and 45.8 % for Luxembourg (Table 2). In the UK and the US the coefficient is slightly above 11 %, whereas for Germany and France it is 20 % and 21 %, respectively. High uncertainties exist for the estimates in Sweden, Italy and Portugal.

Separate errors were estimated for filter uncertainties (uncertainty associated with the estimation technique) and parameter uncertainties (the uncertainty associated with errors regarding the determination of the initial parameters of the NAIRU). The filter uncertainty is larger than the parameter uncertainty. The parameter uncertainty, however, is large at the beginning of the sample period and declines substantially at the end.

Table 1 Sacrifice ratio

Country	Sacrifice Ratio*
Austria	0.52
Belgium	2.01
Denmark	1.18
Finland	2.20
France	0.93
Germany	1.99
Greece	0.84
Ireland	1.84
Italy	1.55
Japan	1.15
Luxembourg	0.62
Netherlands	1.92
Portugal	0.80
Spain ¹¹	
Sweden	2.37
UK	0.68
US	2.34

* cumulative loss in output measured as a percent of one year's GDP associated with a 1 percentage point permanent reduction in inflation.

Source: Gianella et al. (2009) pp. 38-40, *Economix*

Table 2 Standard errors of OECD NAIRU estimates

Country	Average standard error	Relative confidence interval* (%)
Austria	0.30	14,5
Belgium	0.87	21,7
Denmark	0.66	21,9
Finland	0.93	24,8
France	0.93	21,4
Germany	0.71	20,0
Greece	1.09	25,2
Ireland	0.48	8,7
Italy	1.30	31,0
Japan	0.33	20,3
Luxembourg	0.56	45,8
Netherlands	0.45	15,9
Portugal	0.99	29,9
Sweden	0.80	36,9
UK	0.45	11,3
US	0.34	11,4

* average standard error times 1.96 in relation to average NAIRU over sample period

Source: Gianella et al. (2009) pp. 38-40, *Economix*

¹¹ For Spain no value is illustrated by Gianella et al. (2009) for the sacrifice ratio

Second stage: country comparison

In the second step the authors tried to identify the structural determinants influencing the NAIRU. This is done by investigating their impact in a cross-country comparison. Potential determinants are derived from the Philips Curve's underlying wage-setting/price-setting framework. The variables were chosen in regards to the available data:

- Unemployment benefit replacement rate
- Tax wedge
- Union density
- Product market regulations
- Minimum wage legislation¹²

Moreover, the real interest rate was included as the determinant associated with macroeconomic shocks in order to capture changes in user cost of capital. The impact was estimated by using a first difference model.

Estimation results

The structural determinants influencing the NAIRU were estimated for 19 OECD countries, thereof 13 EU countries, for the period 1978 to 2002.

Firstly, a standard pooled regression was undertaken with the following results:

- The tax wedge, product market regulation and the real interest rate have a significant and positive influence on the NAIRU. The adjustment period associated with changes in the interest rate is long.
- The unemployment benefit replacement rate and union density also have a significant impact on the NAIRU with a lag of around two to three years.

The robustness of the results was checked by including:

- time dummies to capture shocks
- instrumental variables to avoid endogeneity bias
- the ratio of gross statutory minimum wages to median wages as an explanatory variable in order to ensure that there is no omitted variable bias in the original model

Including time dummies changed only the impact of the product market regulation by becoming insignificant and the magnitude of real interest rate impact which became lower but nevertheless remained significant. There was no evidence found for an endogeneity bias by applying instrumental variables. Nonetheless, the variables tax wedge and union density became less robust compared to the estimation with fixed effects. To check for an omitted variable bias the statutory minimum wage was included for countries with such regulations. No significant impact could be found.

Secondly, the authors estimated the determinants of the NAIRU by allowing for cross-country heterogeneity. The system of equations was thus estimated in first differences using the seemingly unrelated regression method (SUR¹³) for the 19 OECD countries. By applying this estimation approach the tax wedge, the average unemployment benefit replacement rate, and the product market regulation are significant in 14 countries and the union density in 11 countries. The real interest rate is significant in all countries except Portugal and Japan.

For several countries (Germany, Denmark, Japan, and Portugal) the relationship between NAIRU and institutional variables could not be established. In the case of Germany the quality of data may influence the results, while for Portugal the limited availability of data affected the results. For Japan obviously an omitted variable bias emerged due to the missing financial variables which could capture effects of the banking crisis which occurred during the sample period.

¹² Due to limited availability of this variable it is only tested for a subset of countries.

¹³ See section 3.3.

Summary of OECD results

- The dynamics of the NAIRU can be relatively well explained by the selected structural variables. Exceptions are Germany and Denmark. The fit of estimated equations is better in periods where the NAIRU is declining.
- The tax wedge explains a large part of the observed increase of the NAIRU, in particular in Austria, Spain, Finland, France, Ireland, Italy, the Netherlands, and Sweden. Moreover, a drop in the tax wedge explains the decrease of the NAIRU in Finland, France, Ireland, the Netherlands, and the UK.
- Unemployment benefits pushed the NAIRU especially in the 1980s and early 1990s in Spain, Finland, France, the Netherlands, and Italy. For Italy, Spain, and France the influence of unemployment benefits became more generous between 1993 and 2003.
- Cuts in the average replacement rate reduced the NAIRU in Finland, Sweden, and the UK between 1993 and 2003.
- Product market regulations were alleviated during the sample period in all countries and thus led to a decline in the NAIRU. The highest effect was found for the UK, Spain, Japan, Finland and Denmark.
- Union density also declined in almost all countries and lowered the NAIRU. The largest effect was experienced by Ireland.
- The impact of the user cost of capital could explain an increase of above 1 % in structural unemployment in the 1980s to early 1990s in the UK, Ireland, Austria, Belgium Spain, the Netherlands, and Italy. A decline of the real interest rate in recent years has affected a decline in the NAIRU in most of the countries except Japan.

Mc Morrow and Roeger (2000)

Mc Morrow and Roeger estimated the time-varying NAIRU for EU countries during the period 1990-1999. They used a model where inflation is a function of the unemployment gap and a distributed lag of past inflation.¹⁴ The results are presented in Table 3.

Table 3 NAIRU estimates (1990-1999) by Mc Morrow and Roeger (2000)

	1990	1993	1996	1999
Belgium	8.6	8.5	8.3	8.0
Denmark	6.6	6.5	6.1	5.6
Germany	5.6	6.2	7.4	8.8
Greece	7.3	8.0	9.1	10.1
Spain	18.5	18.9	18.2	16.6
France	9.6	10.2	10.7	11.3
Ireland	14.1	13.4	11.7	9.3
Italy	9.9	10.4	10.9	11.3
Netherlands	7.0	6.3	5.3	4.0
Austria	3.6	3.7	4.0	4.3
Portugal	4.9	5.5	5.4	4.2
Finland	4.7	17.0	14.6	12.2
Sweden	5.9	7.9	7.4	6.5
UK	9.3	8.7	7.8	6.8

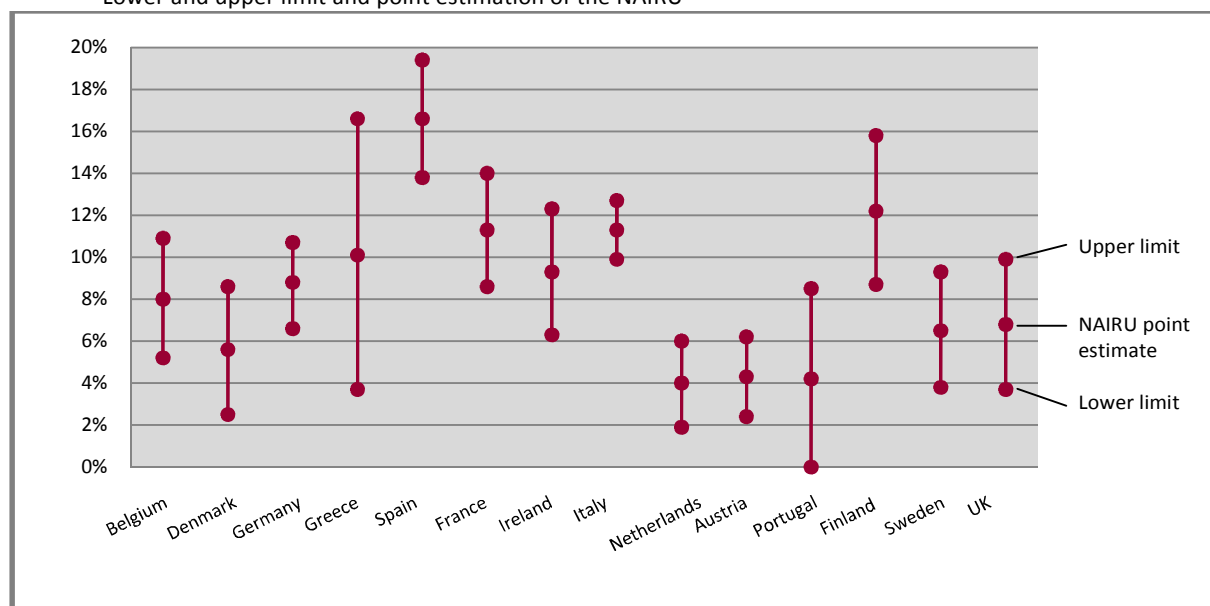
Source: Mc Morrow and Roeger (2000), *Economix*

For the year 1999 information about the 90 % confidence interval is available, showing wide ranges between the lower and upper limit of the point estimate of the NAIRU (Chart 4). Greece has a confidence interval of 12.9 % and Portugal 8.5 %. Germany and the Netherlands have a difference of 4.1 % between the lower and the upper limit. The average difference of all 14 countries is 6.0 %. The chart points towards the high uncertainty of the NAIRU estimates.

¹⁴ Various permutations were used for the estimations including different inflation indicators and various structural variables (Mc Morrow and Roeger 2000, p. 12).

Chart 4 90 % confidence intervals by Mc Marrow and Roeger, estimates for 1999

Lower and upper limit and point estimation of the NAIRU

Source: Mc Marrow and Roeger (2000) p. 14, *Economix*

The comparison between this estimate and the OECD results shows that the estimates of Mc Marrow and Roeger exceed those of Gianella et. al. in 8 of the 14 countries. The exceptions are Denmark, Germany, Greece, the Netherlands, Austria, and Portugal. The deviations between the two estimates are below one percentage point in the majority of countries. The greatest difference of 4.1 % was found to be for Spain (Table 4). The comparison uses the average NAIRU for the period 1990-1999.

Table 4 Comparison of estimation results for the time-varying NAIRU

	Mc Marrow and Roegner (MMR) Average (1990-1999)	Gianella et al (GEA) Average (1990-1999)	Difference MMR-GEA
Belgium	8.35	8.10	0.25
Denmark	6.20	6.50	-0.30
Germany	7.00	7.30	-0.30
Greece	8.63	9.10	-0.48
Spain	18.05	13.95	4.10
France	10.45	9.45	1.00
Ireland	12.13	12.10	0.02
Italy	10.63	9.40	1.23
Netherlands	5.65	5.90	-0.25
Austria	3.90	4.60	-0.70
Portugal	5.00	6.05	-1.05
Finland	12.13	10.30	1.83
Sweden	6.93	4.75	2.18
UK	8.15	8.05	0.10

Source: Calculations by Economix based on Mc Marrow, Roegner (2000) and Gianella et al. (2009)

Stephanides 2006

This study estimated the constant and time-varying NAIRU for the European Union for the 15 initial member states, Japan and the US. The data which was used covered the period 1981 to 2005.

To estimate the time-varying NAIRU the author uses the expectation-augmented Phillips Curve framework with the expected inflation, the unemployment gap and the difference between current unemployment and unemployment from the previous year as explanatory variables.¹⁵ The Kalman filter method was

¹⁵ $\pi_t = \pi_{t-1} - \varepsilon(U_t - U_t^{NAIRU}) - (U_t - U_{t-1}) + \eta_t$, where U is the unemployment rate, U^{NAIRU} the NAIRU and π the inflation rate which was defined by the price deflator of GDP at market prices. The expected inflation is assumed to be represented by the price inflation rate of the previous year. The variable η_t is the error term which is assumed to be independent and white noise.

applied using the Phillips Curve as a measurement equation and a transition equation, which defines the NAIRU as a random walk.¹⁶ The parameters of both equations are estimated with the maximum likelihood using the Kalman filter. The estimation results are presented in Table 5.

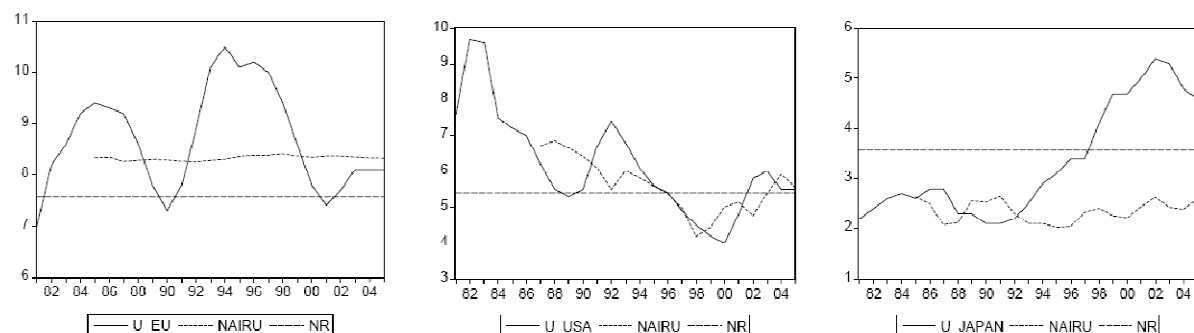
Table 5 Estimation results for the time-varying NAIRU by Stephanides (2006)

Regression parameters for	EU 15	US	Japan
Unemployment gap ε (t-value)	-0.4528 (-29.776)	-0.3707 (-5.201)	-0.1206 (-1.762)
NAIRU 2005 $\hat{\beta}_{2005}$ (t-value)	8.3185 (57.186)	5.569 (8.168)	2.5925 (2.541)
Change of unemployment rate to previous year $\hat{\lambda}$ (t-value)	-0.3553 (-1.936)	-0.0399 (-0.419)	-0.7649 (-0.825)

Source: Stephanides (2006) p. 10, *Economix*

With inflation as the dependent variable of this regression, it is negatively affected by the unemployment gap and the change in unemployment. The illustrated value for β indicates the NAIRU for the year 2005. The author compared the results for the time-varying NAIRU with the results for the constant NAIRU.¹⁷ Both are illustrated in Chart 5. The comparison reveals that in the EU the time-varying NAIRU is higher compared to the constant NAIRU. In the US, the time-variant NAIRU fluctuates around the constant NAIRU and is lower in Japan.¹⁸ The figures confirm the great differences among the NAIRU estimates and the sensitivity of the indicators regarding the methodology. Even though the Kalman filter approach is preferred when estimating the NAIRU, the authors point out that there is little variation in the NAIRU in the EU and Japan. This may lead to mis-specified and unreliable equations, whereas too much variation undermines the concept and makes the NAIRU of limited use for policy purposes (Stephanides 2006, p. 11).

Chart 5 Estimates of time-variant and constant NAIRU



Solid line: actual unemployment rate; dotted line: time-variant NAIRU; dashed line: constant NAIRU (NR)

Source: Stephanides (2006), p.11

¹⁶ Transition equation: $U_t^{NAIRU} = \beta_t = \beta_{t-1} + \eta_{1,t}$, where β_t is the state of a random walk variable and the variable $\eta_{1,t}$ the disturbance term which is independent and white noise.

¹⁷ The constant NAIRU was estimated with the same Phillips Curve framework which was used for the time-varying NAIRU, except for the NAIRU being assumed to be constant over time and independent of t .

¹⁸ The constant NAIRU was estimated by using the non-linear least squares method

2.4. Critical views

There has been a long and intensive debate about the NAIRU concept which has experienced its ups and downs over the past decades. The critical views about the NAIRU have both empirical and theoretical arguments.

- **Staiger, Stock and Watson (1997)** argue that the NAIRU has changed over time. However the measurement of changes remains uncertain as empirical estimates are imprecise. This leads to wide confidential intervals and limits the use of the NAIRU framework for policy purposes and forecasting. Moreover, they argue that the forecasts of inflation, which are based on the deviation of unemployment to the NAIRU, are similar even if the NAIRU varies between 4.5 %, 5.5 % or 6.5 %. Thus, the NAIRU would be misleading for monetary policy.
- **Galbraith (1997)** criticises the practical usefulness of the NAIRU and the theoretical concept. In practice there are different ways of estimating the NAIRU which lead to different results. From a theoretical viewpoint the natural rate of unemployment is not compelling. According to Galbraith the construction of a natural rate of unemployment becomes less important if the Phillips relation fails empirically, meaning that the levels of unemployment do not predict the rate of inflation. The criticism thus arises from the fact that a theoretical argument is based on non-theoretical foundation. Moreover, the empirical evidence of a vertical Phillips Curve is weak, which would invalidate the theoretical considerations that a lower unemployment rate which falls below the NAIRU would accelerate inflation.
- **Chang (1997)** also criticises the NAIRU in his article: “the concept of the NAIRU is of very limited use for predicting inflation, understanding its causes, or forming policy.” He also argues that the NAIRU varies over time and no precise estimate is available which would help to assess whether current unemployment lies above or below the NAIRU. Additionally, he points out that the concept of the NAIRU loses its simplicity if inflation expectations are taken into account. Then the inflation level might change due to inflation expectations which are unrelated to deviations of unemployment from the NAIRU. Moreover, there are problems regarding the NAIRU concept if shocks hit the system. Demand shocks are in line with the theoretical framework but supply shocks could change inflation and unemployment in the same direction. Thus, the NAIRU concept would be misleading.
- **Franz (2003)** mentions that the NAIRU is very difficult to determine: Firstly the whole idea of the NAIRU may be harmed if inflation, wages and unemployment do not behave together. Secondly, in times of low inflation the underlying Phillips Curve may not be vertical as used for the NAIRU derivation. Moreover, the measurement of a number of variables assumes arbitrariness but in fact influences the NAIRU.
- **Akerlof and Shiller (2009)** point out that in modern macroeconomics the phenomena of money illusion is missing. Money illusion occurs when decisions are influenced by nominal prices rather than real prices. Thus, the Philips curve relation would not be valid if people do not take account of inflation in their financial decisions. Workers would not bargain for real wages and firms would not set relative prices for their products.
- **Ball and Mankiw (2002)** support the concept of the NAIRU as a useful piece of business cycle theory. In their view the NAIRU is equal to the natural rate of unemployment, which in theory says that inflation and unemployment are pushed in opposite directions by changes in monetary policy, and in particular by changes in aggregate demand. If this short-run trade-off exists, there must also be a level of unemployment which causes stable inflation. Moreover, they find an explanation for the fluctuations of the NAIRU over time. These fluctuations can be explained by fluctuations in productivity which cause the NAIRU to increase if productivity growth slows down and vice versa.
- **Stiglitz (1997)** also defends the NAIRU and points out that he “has become convinced that the NAIRU is a useful analytic concept”. The NAIRU is, according to Stiglitz, a useful theoretical concept to understand the causes of inflation and on an empirical basis it can be used for predicting changes in the inflation rate. In his article he argues that the NAIRU has changed over time (it has fallen in the US in particular) and explains that the change was caused by the changing demographics of the labour force, productivity growth and the increased competitiveness on labour and product markets. Moreover, the NAIRU provides a useful framework for policy questions even though there is considerable uncertainty about the exact magnitude of the NAIRU.

3. Okun's Law

3.1. Theoretical Framework

Okun's Law supposes a negative correlation between the change of the unemployment rate and real gross domestic product (GDP). The relationship was established by the economist Arthur Okun in 1962 and therefore bears his name. Okun found that for the US a one-percentage point increase (decrease) in unemployment was associated to a three percent decrease (increase) in output.

The law says that the unemployment rate u decreases if real output growth (g_{yt}) is stronger than the trend rate of growth ($\bar{g}_y$)¹⁹ in a country and vice versa. Thus, the change of unemployment (Δu) can be explained by the following equation, illustrating Okun's law:

$$\Delta u = -\beta(g_{yt} - \bar{g}_y) \quad (2)$$

The coefficient β , also known as Okun's coefficient, measures the impact of the GDP growth rate on the unemployment rate. It is understood as being determined by a number of variables which regulate the flexibility of labour markets in certain countries. These are laws regarding employment protection, company organisation, the amount of labour hoarding or demographic changes. In countries with a low flexibility of the labour market the coefficient is expected to be small in absolute terms, meaning that an increase or decrease of GDP has less influence on the unemployment rate than in countries with a higher Okun coefficient. The US is an example of a high coefficient as employment protection is low. On the other hand European countries and Japan have smaller coefficients as these countries have stronger rigidities in their labour markets.

The growth trend ($\bar{g}_y$) cannot be observed and reflects the change of potential output. This depends on the growth rate of the labour force, productivity, technical progress and cost efficiencies (Blanchard and Illing 2004, p. 271). It has to be taken into account that the unemployment rate can increase even with positive growth. This is the case if the actual growth rate is lower than the trend growth rate. Thus, the trend growth rate is also called the unemployment threshold (Schalk et al. 1997).

Both variables, Okun's coefficient and the trend growth rate, vary over time and adapt to external impacts. While Okun's coefficient was quite low in European countries between 1960 and 1980 it increased between 1981 and 2000 due to lower employment protection, which allowed the companies to react more flexibly to changes in demand. During these periods the coefficient for the US remained almost stable (Blanchard and Illing 2004, pp. 270).²⁰

3.2. Okun's Law: original and expanded version

Okun originally described two empirical relationships between real output and the unemployment rate.²¹ These relationships are known as the difference version and the gap version of Okun's Law (Knotek 2007).

The difference version of Okun's Law

This relationship shows how quarterly changes in the unemployment rate are related to quarterly growth in real output and can be illustrated by the following equation:

$$\Delta u = a + b(g_{yt})$$

¹⁹ The trend growth rate is also known as potential growth rate or normal growth rate. It defines the rate with which the production of an economy "normally" grows, meaning that the growth depends either on an increase in labour productivity or a rise of labour force potential (Schalk et al. 1997)

²⁰ For the period 2002-2009 there are no other cross-country studies available for Europe.

²¹ Okun tested three different relationships, two of these can be shown to be mathematically equivalent (Moosa 1997).

In this version b equals Okun's coefficient. The ratio $-a/b$ defines the rate of real growth which is necessary for a constant unemployment rate.

The gap version of Okun's Law

The gap version combines the change of unemployment with the output gap between actual and potential output. The potential output is associated with full employment:

$$\Delta u = c + d(g_{yt} - \bar{g}_y)$$

The potential output is illustrated by the variable $\bar{g}_y$. The unemployment rate which can be interpreted as being associated with full employment is illustrated by c . The variable d is Okun's coefficient.

As the potential output and full employment is not observable, Okun's analysis has been expanded by economists to include variables which were omitted in the original version. Thus, new versions were developed known as the dynamic version and the production-function version (Knotek 2007). The dynamic version has more explanatory variables including current real output growth, past real output growth and past changes of the unemployment rate. A possible estimation could use the following equation including two lags of real output and two lags of the change in unemployment rate:

$$\Delta u_t = \beta_0 + \beta_1 g_{yt} + \beta_2 g_{yt-1} + \beta_3 g_{yt-2} + \beta_4 \Delta u_{t-1} + \beta_5 \Delta u_{t-2}$$

The production-function version includes a theoretical production function in the framework of the gap version. This means that it reflects the way in which labour, capital and technology are combined to produce output.

3.3. Estimation approaches

The estimation of Okun's law and Okun's coefficient were undertaken by many economists. While the number of studies on the US dominate (e.g. Gordon (1984), Weber (1995), Knotek (2007), Yazgan/Yilmazkuday (2009)), there are also studies on other countries (e.g. Knoester (1986) for Germany, Netherlands, UK, and the US; Moosa (1997) for the G7 countries; Lee (2000) for 16 OECD countries; Sögner/Stiassny (2002) for 15 OECD countries; and Malley/Molana (2008) for the G7 countries). The studies apply time series data for different time periods and use different methods for estimation. The most common estimation methods are shortly illustrated in the following paragraphs.

Ordinary least squares (OLS)

The OLS method is a common regression procedure which is used to estimate the influence of explanatory variables on a dependent variable by minimising the deviation of existing points to the estimated regression line. The **rolling OLS method** is a technique which can be used to estimate a particular relationship over many different sample periods (Knotek 2007). This is useful for estimating Okun's Law as the relationship between unemployment and output growth has changed over time due to economic shocks and changes in the labour market structure. This variation cannot be captured by the standard OLS method.

Seemingly unrelated regression (SUR)

The SUR technique was established by Arnold Zellner (Zellner 1962) and can be used to capture cross-country correlations. The method was established for analysing systems of multiple equations with cross-equation parameter restrictions and correlated error terms. This is useful if the system contains independent equations which rely on a common data set. Data errors may be correlated across equations. SUR is an extension of the linear regression model which allows correlated errors between equations. In the context of Okun's relationship some researchers applied this methodology (Moosa 1997).

The Hodrick-Prescott filter

The Hodrick-Prescott filter was established by Robert J. Hodrick and Edward C. Prescott (Hodrick and Prescott 1997) and is a univariate technique to decompose a time series into a trend component and cyclical component. It is widely used to identify business cycle dynamics (Lee 2000).

The Beveridge-Nelson filter

The Beveridge-Nelson filter is also a univariate data decomposition method and was established by Stephen Beveridge and Charles R. Nelson (Beveridge and Nelson 1981). It can be used for non-stationary time series.

The Kalman filter

The Kalman filter approach is commonly used for estimating the NAIRU (see section 2.2). In the context of estimating the stability of Okun's law, the Kalman filter is applied to discern unemployment and output gaps from the Phillips Curve relationship (Lee 2000). This method provides efficient use of all information included in the data and thus is superior to the rolling regression method (Sögner and Stiassny 2002).

Bayesian method

The Bayesian method can be used to provide an unknown parameter which has a prior distribution. The so-called Bayesian estimation is allowed if it is possible to switch between a limited number of states, i.e. switching the regression model (Sögner and Stiassny 2002).

3.4. Estimation results

The estimation results of different studies investigating Okun's Law are summarised here. The illustration is limited to results for the EU member states, the US and Japan:

- Moosa (1997) estimated Okun's coefficient for the G7 countries by using OLS, rolling OLS, and SUR.
- Lee (2000) estimated the gap version of Okun's Law for 16 OECD countries using the Hodrick-Prescott filter, the Beveridge-Nelson filter, and the Kalman filter
- Sögner and Stiassny (2002) applied the Bayesian methods to examine discrete changes in the relationship given by Okun's Law, and the Kalman filter to investigate "continuous" changes of 15 OECD countries.
- Malley and Molana (2008) estimated Okun's Law for the G7 countries using a production function approach

Moosa (1997)

Model

Moosa used a bivariate model for the estimation applying annual data from the years 1960-1995. The specification of Okun's Law is represented by the following equation:²²

$$u_{i,t}^c = \alpha + \beta u_{i,t-1}^c + \gamma y_{i,t}^c + \varepsilon_{i,t}$$

where y^c is the logarithm of cyclical output. This is understood as the output gap, which is the difference between actual and potential output.²³ The variable u^c illustrates the cyclical unemployment rate which is the difference between the actual and the natural rate of unemployment and is also known as the unemployment gap. γ defines Okun's coefficient. The variable ε is a stochastic term where the subscript i denotes country i . The cyclical components of unemployment and output were extracted by using a structural time series model which was invented by Harvey (1985, 1989).²⁴ With this kind of specification it was possible for Moosa to calculate the long-run effect of cyclical output on cyclical unemployment given by $\theta = \gamma/(1 - \beta)$.

²² This specification was also used by Weber (1995)

²³ Output is represented by real GDP in national currencies at 1985 prices except for the US (1987).

²⁴ For a precise deviation please see Moosa (1997), pp 340-345

Estimation results

Okun's coefficient, illustrated by the variable γ , was the highest for the US and the lowest for Japan during the sample period (Table 6). The coefficients for Germany, France and the UK were closer to the US level, while Italy was significantly lower. The long-run response of cyclical unemployment to output θ was higher than Okun's coefficient. This applied to all countries. The ratio of γ to θ is lower in Italy and Germany, which means that the long-run adjustments took longer than one year in these countries.

Table 6 OLS estimations for Okun's coefficient by Moosa (1997)

Variable	US	Japan	Germany	France	UK	Italy
Okun's coefficient γ (t-value)	-0.456 (-36.07)	-0.088 (-9.02)	-0.407 (-9.33)	-0.363 (-24.36)	-0.372 (-19.29)	-0.184 (-5.22)
Long-term effect θ (t-values)	-0.491 (-46.13)	-0.123 (-12.21)	-0.617 (-15.56)	-0.442 (-36.27)	-0.479 (-32.92)	-0.316 (-5.48)

Source: Moosa (1997), p. 349, *Economix*

The model was also tested for structural stability with a breakpoint in 1973 (oil crisis) by using Chow tests. For the US, Japan, and Italy the model passed the tests, whereas it failed for Germany and the UK. France only passed one test.

By using the rolling OLS method Moosa received rather stable coefficients for the US and the UK. The coefficients increased in absolute terms for Germany, France, and Japan and decreased for Italy. The sample period was separated into periods of 14 years in order to capture variations in Okun's relationship due to changes in labour market behaviour. The SUR estimation results are similar to the results received by the OLS estimation.

Table 7 Basic statistics for rolling OLS estimations by Moosa (1997)

Country	Maximum	Minimum	Mean	Coefficient of variation
US	-0.477	-0.432	-0.456	0.036
Japan	-0.122	-0.063	-0.083	0.192
Germany	-0.642	-0.213	-0.410	0.320
France	-0.409	-0.243	-0.217	0.167
UK	-0.414	-0.369	-0.392	0.031
Italy	-0.285	-0.113	-0.175	0.337

Source: Moosa (1997), p. 352

Conclusions

The findings for the US and Europe can partly be explained by institutional differences between these countries. The values of Okun's coefficient were judged to be reasonable for the US and the UK, as the US has had a flexible labour market for a long time and the UK increased flexibility by abolishing minimum wages and reducing trade union power during the sample period. The low values for Italy and Japan on the other hand were explained by the restrictions of the labour markets in these countries. The values for Germany and France were assessed as being too high. The author assumed that the bivariate model overestimated Okun's coefficient due to the existence of omitted variables such as productivity or hours worked.

From the results of the rolling OLS estimation the author concluded that an increase in absolute values of Okun's coefficient occurred in Germany, France and Japan due to labour market reforms in the later years of the sample period. Thus, the value in the US stayed stable due to a lack of reforms regarding the labour market. In the case of the UK no appropriate explanation for the stable value was found with regard to labour market reforms.

Lee (2000)

Lee estimated Okun's coefficient for 16 OECD countries using post war data. He applied the first-difference version and the gap model and concluded that estimation results are related to the choice of the model. Moreover, he found strong evidence for structural breaks for the period around 1970.

Model

While Okun developed the model by using the unemployment rate as a dependent variable and output as an explaining variable, Lee applied the relationship the other way around. The applied first difference model is illustrated by the following equation, where Δ is the first difference operator, β_1 Okun's coefficient, and ε_t a white-noise disturbance term:

$$\Delta y_t = \beta_0 - \beta_1 \Delta u_t + \varepsilon_t$$

The gap version is shown by the following equation:

$$y_t - y_t^* = -\beta_1(u_t - u_t^*) + \varepsilon_t$$

where y_t^* is the potential output and u_t^* the normal rate of unemployment. The difference between the potential and actual output can be expressed by the cyclical output growth $y_t - y_t^* \equiv y_t^c$ and the cyclical unemployment in terms of unemployment $u_t - u_t^* \equiv u_t^c$. For decomposition Lee used the Hodrick-Prescott filter, the Nelson-Beveridge filter and the Kalman filter.

Estimation results

In the reverted form of Okun's Law which was used by Lee, a high coefficient $-\beta_1$ represents a country with high rigidities concerning the labour market. While the majority of values are significant, only the values for Italy for the Kalman filter estimation and for the Netherlands for the Beveridge-Nelson estimation are insignificant (Table 8). The values for all countries are similar but still vary depending on which of the different models were applied. The highest value is 12.6 (Kalman filter) for Japan, which reflects the rigidity of its labour market during the sample period.

Table 8 Lee's estimation of Okun's coefficient

Country	First Difference	Kalman filter	Hodrick-Prescott	Beveridge-Nelson
Austria	3.68	4.17	3.51	3.82
Belgium	1.09	1.05	1.12	1.03
Denmark	1.21	0.99	1.03	1.30
Finland	1.73	1.44	1.63	1.73
France	2.91	2.50	2.20	2.91
Germany	2.47	1.72	2.18	1.77
Italy	1.09		0.57	2.41
Japan	4.41	12.6	6.55	5.48
Netherlands	1.11	1.13	1.42	
Sweden	1.87	1.69	1.54	1.68
UK	1.39	1.49	1.41	1.51
US	1.84	1.88	2.09	2.03

Source: Lee (2000), p. 341, *Economix*

The author also tested for structural instability of Okun's relationship by applying the Quandt Likelihood Ratio (QLR) test. He found evidence for instability and could specify the periods which were associated with the maximum QLR statistics. The break points spread over different periods. Some coincide with the oil crisis in 1973, whereas in other countries the break points are distributed throughout the 80s which might be associated with labour market reforms.

As evidence was found regarding the instability of Okun's relationship over time, Lee integrated dummy variables in the model in order to differentiate Okun's coefficient for different sample periods. According

to the results the coefficients vary over time and the impact of increased unemployment on output decreased in the last decades of the sample period. Moreover, the coefficients for European countries, especially EU member states, were higher in absolute terms compared to those of the US.

Conclusions

Okun's Law relationship was generally supported by the results presented by Lee. Quantitative estimates differ across countries, however the results are not robust. The estimates for Okun's coefficient are associated with higher rigidities on European labour markets compared to the US during the sample period. Moreover, the change of coefficients indicates more flexibility on the labour market in Europe at a later date within the sample period.

Sögner and Stiasny (2002)

Sögner and Stiasny investigated Okun's Law and its structural stability for 15 OECD countries. Moreover, they identified whether structural instability was caused from supply side shocks or demand side shocks. For the estimation of Okun's Law, the Kalman filter analysis and Bayesian analysis methods were applied using time series data for the period 1960-1999.²⁵

Model

The estimation of the first difference version of Okun's Law used an expanded formula in order to capture lagged labour market reactions:²⁶

$$\begin{aligned}\Delta u_t &= a_0 + a_1 \Delta y_t + a_2 \Delta y_{t-1} + v_t \\ \Delta u_t &= a_0 + a_1 \Delta^2 y_t + (a_1 + a_2) \Delta y_{t-1} + v_t\end{aligned}$$

where a_1 refers to the effect of output growth changes and $(a_1 + a_2)$ to the total effect (Okun's coefficient).

The structural stability was checked by investigating changes in labour demand and supply with the following relationship:²⁷

$$\begin{aligned}u_t &\approx n_t - l_t \Rightarrow \\ \Delta u_t &\approx \Delta n_t - \Delta l_t\end{aligned}$$

where n_t is the logarithm of the labour force and l_t the log of employment. This relationship leads to the following equations which can also be estimated by OLS:

$$\begin{aligned}\Delta n_t &= \alpha_0 + \alpha_1 \Delta^2 y_t + (\alpha_1 + \alpha_2) \Delta y_{t-1} + v_{n,t} \\ \Delta l_t &= \beta_0 + \beta_1 \Delta^2 y_t + (\beta_1 + \beta_2) \Delta y_{t-1} + v_{l,t}\end{aligned}$$

Estimation results

The Okun coefficients range between -0.12 to -0.82 among the countries observed (Table 9). The lowest coefficient was found to be for Japan and the highest for the Netherlands.

²⁵ Data for the time period 1960-1989 was used for Germany

²⁶ This specification was also applied by Weber (1995)

²⁷ Further derivation can be found in Sögner and Stiasny (2002) pp. 1776-1777

Table 9 Okun's coefficient by Sögner and Stiassny (2002)

Country	$\hat{\alpha}_1$	$(\hat{\alpha}_1 + \hat{\alpha}_2)$	Break 82
Japan	-0.05	-0.12	**
Austria	-0.10	-0.15	
Italy	-0.09	-0.21	
Sweden	-0.28	-0.35	***
Germany	-0.29	-0.38	**
France	-0.30	-0.43	***
Denmark	-0.31	-0.47	**
US	-0.41	-0.52	**
Belgium	-0.33	-0.57	
UK	-0.31	-0.58	*
Finland	-0.35	-0.61	***
Netherlands	-0.42	-0.82	**

Source: Sögner and Stiassny (2002) p. 1779, *Economix*

The structural stability was tested by applying a Chow test in order to identify structural breaks in the years 1982 and 1983. The results are illustrated in the last column of Table 9. Significant break points are indicated by *, **, and ***, corresponding with significance levels of 10 %, 5 % and 1 %. Such break points were identified in 9 of the 12 countries observed. This confirms the variance of the estimates over time.

The effect of output growth on the labour force or employment is outlined in Table 10. Okun's coefficient can roughly be divided into both effects, meaning that:

$$\alpha_1 + \alpha_2 \approx \beta_1 + \beta_2 - \alpha_1 - \alpha_2.$$

The country which had the weakest effect of output growth on the labour force ($\hat{\alpha}_1 + \hat{\alpha}_2$) during the sample period was the Netherlands, while Sweden, the US and Germany had the strongest. The effects also vary for the impact of output growth on employment ($\hat{\beta}_1 + \hat{\beta}_2$). In this context, Japan had the lowest coefficient, while the strongest was found to be for the US.

Table 10 Impact of output growth on labour force and employment by Sögner and Stiassny (2002)

Country	$(\hat{\alpha}_1 + \hat{\alpha}_2)$ (effect of output on labour force)	Break 82	$(\hat{\beta}_1 + \hat{\beta}_2)$ (effect of output on employment)	Break 82
Japan	0.17		0.25	**
Austria	0.28		0.45	
Italy	0.23		0.49	
Sweden	0.48	***	0.83	***
Germany	0.36		0.76	
France	0.28	*	0.63	**
Denmark	0.19	*	0.69	
US	0.37	***	0.96	
Belgium	0.12	*	0.52	***
UK	0.01		0.65	
Finland	0.26	**	0.94	**
Netherlands	-0.01		0.84	

Source: Sögner and Stiassny (2002) p. 1780, *Economix*

Continuous parameter change was investigated using the Kalman filter. For some countries Okun's coefficients either stayed stable (US) or decreased. The decrease of the coefficient might have been influenced by an increase of GDP variation on employment (Finland) or a decrease of labour force elasticity (Germany, France).

Conclusions

Okun's coefficient differs across countries. The stability of the relationship was tested and continuous changes could be found with the help of the Kalman filter method for Germany, Denmark, Finland, France, UK, Japan, the Netherlands, and Sweden. For the remaining countries (Austria, Belgium, Italy, and US) a stable relationship was inferred. The changes in Okun's relation can be assigned to either supply side changes or demand side changes. For the majority of the countries the change was caused by reactions to labour demand (employment), whereas for Germany and France the change was caused by labour supply (labour force).

Finally Sögner and Stiassny could infer that countries which have a highly protected labour market have lower reactions of employment on GDP growth due to labour hoarding and that these countries therefore have a stronger persistence in the unemployment rate.

Malley and Molana (2008)

This study investigated systematic deviations of Okun's relationship in the G7 countries. It started with the view that the relationship between output and unemployment may break down when conditions of labour markets are modified to adapt to rigidities or distortions as for example, efficiency wages, unionisation, wage contracts, and unemployment insurance. The estimation used time series data over the period 1960-2001.

Model

The authors took the production function as a starting point because it traces the combination of employment l and output y at any time for the corresponding level of labour productivity q .

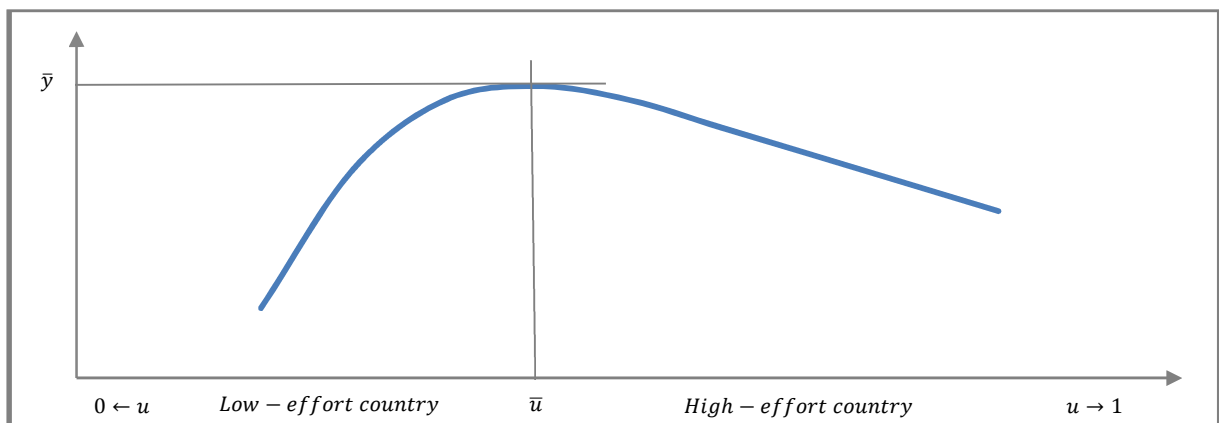
$$y = y(q, l); \quad y'_q > 0; \quad y'_l > 0$$

The authors postulate that the productivity of labour is determined by the level of workers' effort which is positively related to the unemployment rate. This means that $dq/du > 0$ which indicates that the workers' productivity is higher if unemployment is high and vice versa. Thus the relationship between unemployment and output depends on the following correlation:

$$\frac{dy}{du} = y'_q \frac{dq}{du} + y'_l \frac{dl}{du}$$

where the sign of dy/du depends on the magnitude of the effect of $y'_l \frac{dl}{du}$ as $dl/du < 0$. Thus, the authors assume that the production function follows a parable which is opened downwards. This implies that the term dy/du is positive if the unemployment rate falls below a certain threshold ($\bar{u}$), or is negative if the employment exceeds the threshold. The relationship is illustrated in Chart 6.

Chart 6 The relationship between output and unemployment



Source: Malley and Molana (2008), *Economix*

The threshold defines the level of effort in a country. Countries which have an unemployment rate $u > \bar{u}$, can be categorised as 'high-effort' countries while countries with $u < \bar{u}$, can be said to be 'low-effort' countries. In 'high-effort' countries an increase in output can only be realised by an increase in employment. In 'low-effort' countries on the other hand, a higher level of output can be achieved at a lower level of employment. This, according to the authors, depends on the fact that high unemployment induces an increase in effort of the employees. This compensates the effect of reduced employment on output. Thus Okun's Law can only be applied to the 'high-effort' countries, in which a negative demand shock would increase unemployment. In 'low-effort' countries the application of Okun's Law is only possible if a negative demand shock is combined with a proper shift of the production function.

Estimation results

The authors estimated the relationship using the Kalman filtering method.²⁸ Positive thresholds were found for all countries. According to the results $u > \bar{u}$ only holds true for Germany. In the UK and France $u > \bar{u}$ is much less expressed, and the remaining countries (US, Italy, and Japan) fully reject $u > \bar{u}$.

Conclusions

The authors showed that labour productivity might fluctuate with regards to the level of unemployment. Thus, it first has to be determined if a state is a low or a high-effort state in order to use macroeconomic policies to reduce unemployment by increasing output. The authors state that the threshold unemployment rate in their study might be similar to the NAIRU.

Overview of Okun's coefficient for selected countries

The results for Okun's coefficient from the presented studies are illustrated in Table 11. The estimation results of Lee have been adjusted to the outline of the other studies. Only the G7 countries without Canada are illustrated due to data availability.

The absolute value for the US is quite stable in all studies and lies at around 0.5. The highest average coefficient was found to be for Italy. The high value for the UK on the other hand is seen as being the result of rising flexibility of labour markets. This is consistent with the NAIRU estimates for the UK. Okun's coefficient is the lowest in Japan. The values for France and Germany vary between those for the US and Japan. Nevertheless, the values, especially for Germany, are quite close to the coefficients for the US.

Table 11 Overview of Okun's coefficient by studies

Study	US	Japan	Germany	France	UK	Italy
Moosa (1997)	-0.456	-0.088	-0.407	-0.363	-0.372	-0.184
Lee (2000)						
First Difference	-0.543	-0.227	-0.405	-0.344	-0.719	-0.917
Kalman filter	-0.532	-0.079	-0.581	-0.400	-0.671	
Hodrick-Prescott	-0.478	-0.153	-0.459	-0.455	-0.709	-1.754
Beveridge-Nelson	-0.493	-0.182	-0.565	-0.344	-0.662	-0.415
Sögner Stiassny (2002)	-0.52	-0.12	-0.38	-0.43	-0.58	-0.21
Average of all studies	-0.504	-0.142	-0.466	-0.389	-0.619	-0.696

Source: *Economix*

3.5. Critical views

- **Blanchard and Illing (2004)** assess the empirical relationship of Okun's Law as quite uncertain. Increased production could also be realised with the use of other factors of production if labour is relatively expensive compared to capital. Thus, a rise in output does not naturally cause increased recruitment. Moreover, the trend output changes over time depending on the production factors and growth of labour force. Es-

²⁸ See Malley and Molana (2008), pp. 114-115

estimated parameter values might change over time and relationships might not be stable. As the trend growth rate is unobservable it has to be estimated, which raises the uncertainty of its interpretation.

- **Knotek (2007)** defines Okun's Law more as a rule of thumb rather than a law which is always valid. There have been many exceptions where a slowdown in growth did not coincide with increasing unemployment. Moreover, Okun's relationship is unstable over business cycles as the relationship can vary in recessions and expansions.
- **Malley and Molana (2008)** expanded the relationship between unemployment and output with the productivity of workers. According to them, Okun's Law only holds true if the investigated countries are so-called high-effort countries. Otherwise, an increase in unemployment leads to a rise in productivity which compensates the output loss due to lower employment.

4. Empirical application of approaches

The financial crisis started in the US with the grave breakdown of the real estate prices and plunged the world economy into a deep recession. In 2009 the GDP shrunk in many of the large economies and only the Asian countries like China and India showed positive growth rates. In this context some questions have arisen: Can the theoretical framework of the NAIRU and Okun's Law be practically used to predict the impact of the financial crisis on the unemployment rates? If that is possible what would it mean for policy implications? Moreover, can Okun's coefficient be used to predict the GDP growth needed to stabilise employment? Finally, how would the acknowledgement of short time working influence the indicators?

The following section will investigate these questions on the basis of available estimates and most recent data on unemployment, inflation and GDP growth. It has to be stated that the latest values for the NAIRU estimates in OECD countries reach until the year 2007 and for Okun's coefficient until the year 2002. For demonstration purposes therefore, we estimated Okun's coefficient on the basis of OECD data for 1997 to 2009. This will answer the question how the coefficient can be used to estimate expected unemployment rates with forecasted GDP growth rates. Regarding the NAIRU we will compare available estimates since 1970 with effective data until 2009. This will indicate the relation between inflation and unemployment and the relation of the NAIRU to long-term unemployment.

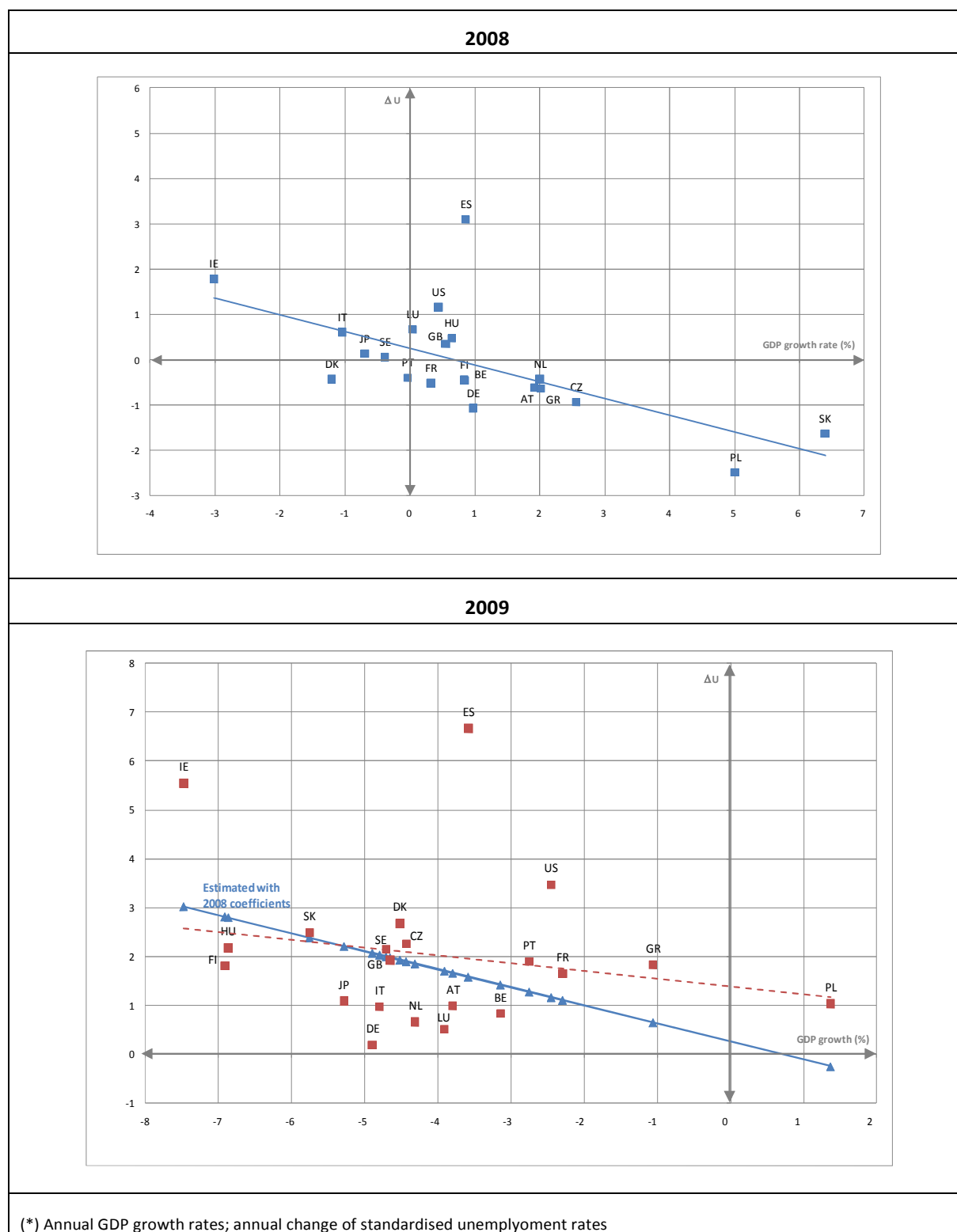
Okun's law as a predictor of unemployment

The relation between the annual GDP growth rate and the annual change of the unemployment rate (Δu) is shown in Chart 7 for the years 2008 and 2009. It can be seen that the negative correlation postulated by Okun is valid in both years. The negative correlation is nevertheless much more distinctive in 2008 than in 2009.

In 2008 the economies were not yet fully hit by the financial crisis. GDP growth was positive in most of the 21 observed countries which include the US and Japan. The labour market however started to show a scattered picture: in 9 countries unemployment rates increased, and decreased in 12 countries. In particular, four countries showed rising unemployment rates in spite of (still) positive growth. Spain experienced an increase by three percentage points in that year, and the US by more than one percentage point. Great Britain and Hungary were also among the countries with rising unemployment in a period of positive output growth. This observation points to the fact that GDP growth and unemployment do not develop synchronically.

In 2009, unemployment rates rose in all countries together with the decline of GDP. The observed countries therefore behaved according to Okun's Law. The variation of changes however increased considerably. While the mean change of annual unemployment rates was 1.2 percentage points in 2008, it increased to 1.6 percentage points in 2009. This was also well above the average change between 1997 and 2009 which also was 1.2 percentage points for the countries observed.

The test how Okun's Law can be used to forecast unemployment on the basis of given or forecasted GDP growth rates was now undertaken by estimating linear regressions for each year in a cross-country com-

Chart 7 GDP growth and change of unemployment rates for selected OECD countries*

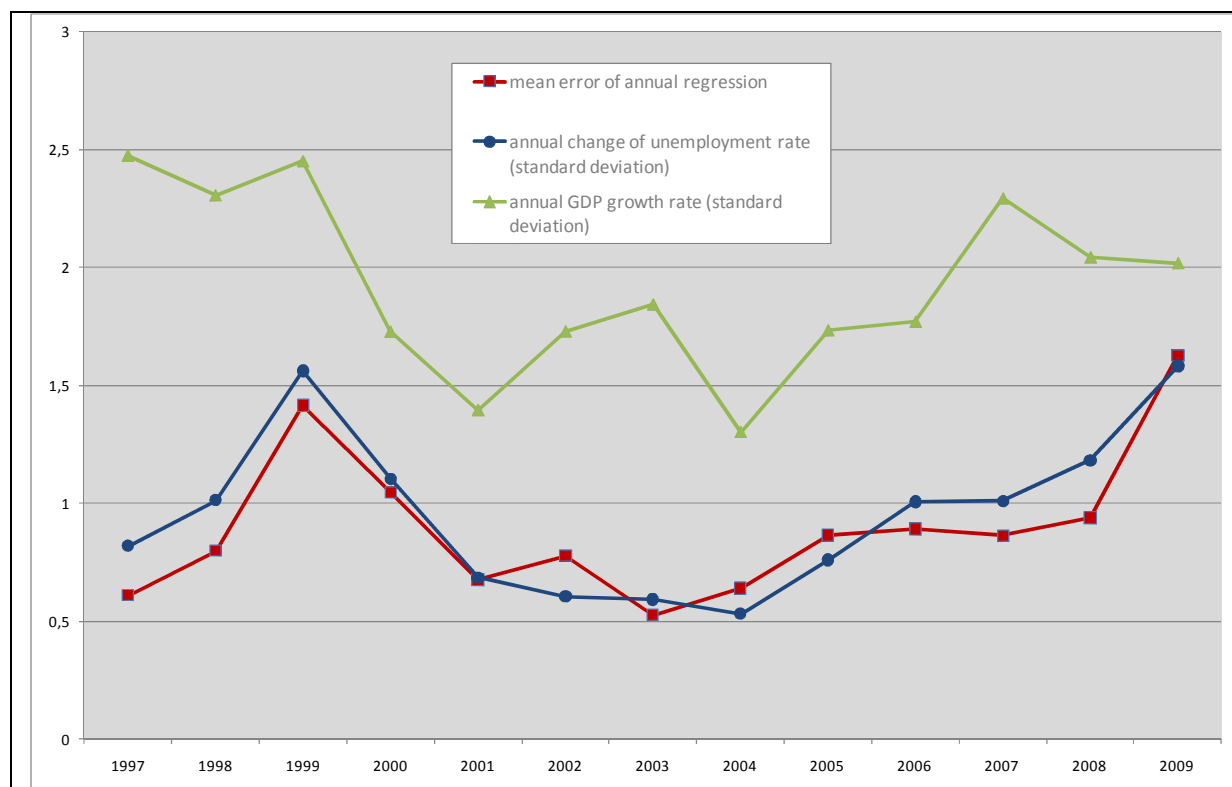
parison. For 2008 this is indicated in Chart 7 by the blue line from upper left to lower right. The regression line was used in 2009 together with the GDP growth rates for this year to estimate the expected change of unemployment rates. It provides an ex post test of the forecasting quality of the presented approach for the two years 2008 and 2009. Further down the results of the estimates for all years since 1997 will be presented.

The values estimated for 2009 on the basis of the regression line for 2008 and the 2009 GDP growth rates are indicated for each country by the blue triangles. The mean estimation error (the average deviation of estimates from real values) amounts to 1.6 percentage points. It equals the mean change of unemployment rates in 2009. No information gain has thus been achieved by the estimate.

Most importantly, however, this estimate does not reflect the change of employment behaviour in 2009 which was characterised by substantial labour hoarding. This is represented by the dotted red line in Chart 7 which results from the original 2009 regression. It shows a significantly higher intersection and a lower slope compared to the 2008 estimate. This means that the observed countries did not react to the decline of GDP in the same way as this was observed in the previous year. A series of countries was able to stabilise unemployment rates with the help of working time adjustments. Germany, Luxembourg, Netherlands, Italy, Austria and Belgium were well below the estimated values of unemployment increase, while Spain, the US, Denmark Portugal, France, Greece and Poland were well above the expected values.

Finally, it has to be stated that the comparison of annual data does not accurately reflect the timing of labour force adjustment to the variation of production levels in the different countries. A more sophisticated lag structure might be able to provide better results. The comparison between 2008 and 2009 however indicates that substantial changes of these lag structures must be assumed. Obviously, the severe downturn of the economies in 2009 was not expected to sustain, and the preservation of human capital appeared to be a necessary condition for the next upswing. Thus employers in some countries kept their staff as far as possible.

Chart 8 Variation of GDP growth and the change of unemployment rates for 21 OECD countries



Source: OECD, Economix

This interpretation of the results lessens the information value of Okun's coefficient significantly. The coefficient calculated in this way, neither reflects the change of employer behaviour over the business cycle nor does it accurately represent the differences between countries. Chart 8 confirms this for the longer observation period from 1997 to 2009. Again, the mean error of annual regression estimates of the change of unemployment rates in single years – estimated with the regression parameters of the previous year and the current GDP growth rates – is close to the actual standard deviation of the annual change of unemployment rates. This means that the estimates do not contribute to the explanation of variance.

The use of Okun's Law to predict the change of unemployment rates is therefore limited. The theoretical framework takes into account neither political actions nor company initiatives like the reduction of working hours. This means that predictions based on this theory would be incomplete.

Short time working schemes are not considered in Okun's model. Of course, such changes can be integrated in the estimation approaches by using hours worked rather than the number of persons employed, and translating short-time workers into "full-time unemployed". The problem however is not just a missing variable. The inclusion of the working time dimension requires developing a theory of working-time behaviour which reflects the adjustment of working hours in the course of the business cycle. This – on one hand – is far from being evident and on the other hand shows a great variety among countries.

The NAIRU mechanism

According to the theory, the NAIRU is expected to indicate the long-term equilibrium on both product and labour markets. It reflects the behaviour of the economy as a "structural" relation between inflation and unemployment that cannot be changed in the short-term and thus measures the inflexibilities on both markets. It describes the systemic behaviour of an economy without defining target values.

In Chart 9 the OECD estimates of the NAIRU, the actual unemployment rates and the actual inflation rates²⁹ are illustrated for six EU countries for the period of 1970 to 2009. The countries were selected considering their different paths of the NAIRU, membership in the monetary union, and differences in the labour market regimes. They thus represent a great variety within the European Union.

From the theory, it can be expected that unemployment levels above the NAIRU will lead to low inflation while levels below will lead to high inflation. This, however, is not what can be observed. We see a strong deceleration of inflation in all six countries during the 1975 to 2000 period which was accompanied by a similarly strong rise of unemployment rates.³⁰ After 2000 inflation remained at rather low levels while unemployment tended to remain above the NAIRU. The relation between the actual unemployment rate and the NAIRU however does not seem to be directly related to the deceleration or acceleration of inflation.

Overall, it is the direct correlation between inflation rates and unemployment rates rather than the NAIRU mechanism which can be observed, before 2000 and after the world crisis in 2008. This is much closer to the traditional Phillips Curve approach. What happened during the 1970s and 1980s is that monetary policy became more and more restrictive, enforcing monetary stability in many countries. Together with other factors, like the rise of oil prices, this was at the expense of rising unemployment. It continued until the 2008 crisis which forced central banks to flood the economies with liquidity while product markets shrunk under the financial shock. Until now the unprecedented decline of world production made unemployment rates rise without inflation.

It remains rather unclear what the NAIRU indicates in this context. The restrictive monetary policy obviously raised the NAIRU to high levels up until 2000. Product and labour markets on the other side did not react adequately to the higher sensitivity of monetary policy to inflationary tendencies. This can be observed in countries like Germany, France and Sweden where the NAIRU kept to its high levels during the first decade of the millennium. The UK, Spain and Finland, however, saw a strong reaction of product and labour markets, expressed by decreasing NAIRU levels. Particularly Spain achieved significantly lower

²⁹ For the inflation rate the consumer price is applied

³⁰ For Germany, the pre-unification values are not comparable to the period after 1990. They are therefore not included in the Chart. The period from 1970 to 1990 was nevertheless characterised by continuously increasing unemployment rates.

levels with the accession to the monetary union. In the UK the decrease of the NAIRU started earlier in the 1980s, presumably triggered by the liberal economic policies of the Thatcher period. Thus the NAIRU appears to indicate the fundamental changes of monetary policies and market reactions. However, the direct links to policy measures remain speculative and vague.

The developments during the financial crisis, finally, show that the NAIRU concept does not fully reveal the causal relationships between inflation and unemployment. It was the slump of world economic output as the result of the financial crisis which raised unemployment and forced central banks to expand liquidity. Inflation rates nevertheless declined and in all countries observed. This happened in spite of monetary expansion. Overcapacities in the production of goods and services set effective limits to inflation and forced labour out of work. Considering the extremely low price and wage pressure, the NAIRU can be expected to show a decline in this phase.

This however characterises the NAIRU as a dependent variable rather than a long-term independent or structural determinant. Inflation and unemployment are linked by short-term economic cycles rather than via their relative position to a structural component called NAIRU. They result from policy behaviour in this context and are defined in a multi-dimensional rather than two-dimensional space. The efforts of economic theory to put the macro-economy into a nutshell thus fail as they ignore important phenomena – money illusion for example – and exclude relevant independent determinants – monetary policies for example. Being aware of this fact, monetarism recommended monetary policies to refrain from cyclical interventions and thus to behave in compliance with the theoretical postulate. This idea however died in the turmoil of the financial crisis.

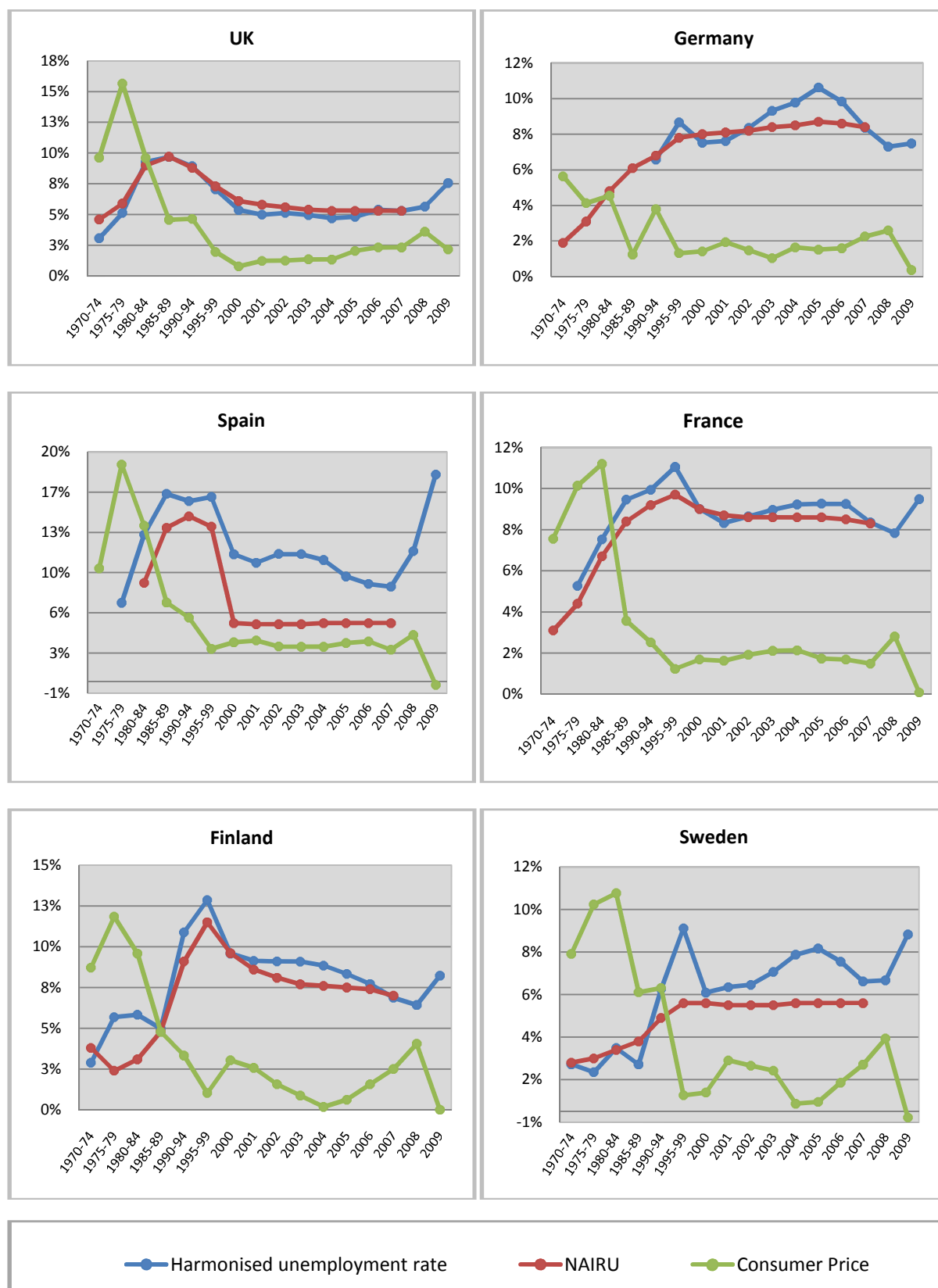
Beyond its theoretical limitations, the NAIRU may nevertheless be used as an empirical description of price and wage stickiness and thus describe a major cause of long-term unemployment from the viewpoint of neoclassical theory. This question is addressed in Chart 10, where NAIRU estimates and long term unemployment rates are compared for the six selected countries. It can be seen that the NAIRU develops more or less in parallel to the rate of long-term unemployment, however at a much higher level in all countries. The coefficient of correlation is 0.683 for these countries in the periods of common observation. This means a positive and significant correlation between NAIRU and long-term unemployment.

The NAIRU as an evaluation indicator

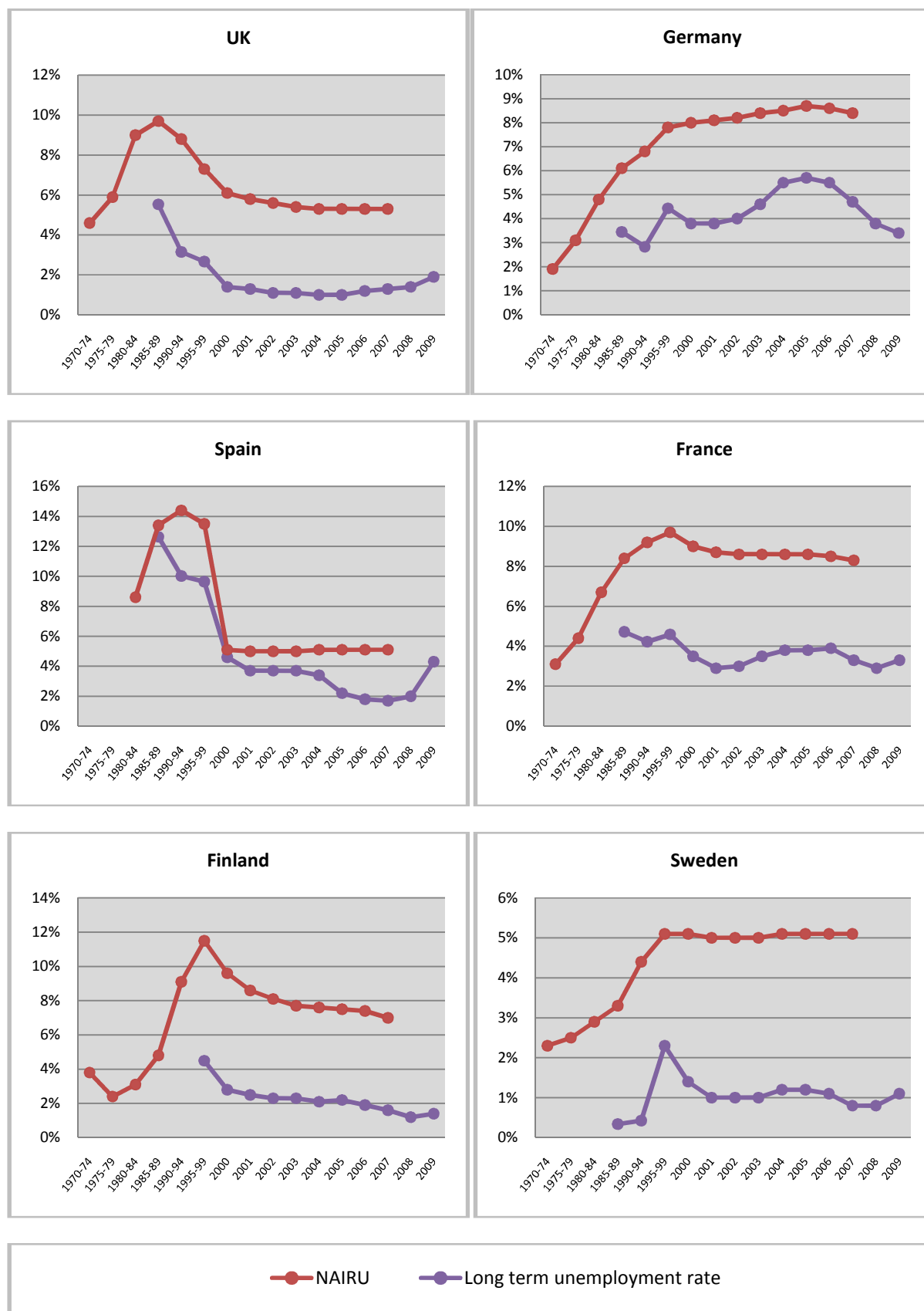
Can the NAIRU thus be used as an indicator for structural and labour market imbalances? The answer is no rather than yes, for two reasons.

- (1) It still remains unclear, what the NAIRU exactly measures and what it indicates. The positive correlation with long-term unemployment does not explain the significantly higher level of the NAIRU, which may be addressed to price behaviour but also to the long-term view of companies regarding the preservation of their human capital basis.
- (2) The complex calculation of the NAIRU creates even longer lags than the statistical measurement of other structural indicators, like the long-term unemployment rate, price and wage flexibility, overcapacities etc. For this reason the indicator appears to be too slow for short-term monitoring purposes.

Beyond the problems with timeliness, these arguments raise the question which NAIRU level should be targeted – a low or a high one. The low NAIRU is reasonable if highly flexible labour markets are assumed to lead to the economic optimum. A high NAIRU appears to be appropriate if the losses of human capital in a highly flexible labour market are considered to be high. In the long-term perspective therefore the non-adjustment of labour inputs appears to be superior to short-term fluctuations. The NAIRU concept thus is only applicable within the neoclassical framework and omits important policy impacts. As the functioning of the NAIRU mechanism can hardly be observed in the time series, the approach is not useful to predict the impact of cyclical changes on labour markets and is no adequate indicator for labour market policies. Its value as evaluation indicator remains limited as changes cannot clearly be associated with policy action.

Chart 9 NAIRU, unemployment rate and inflation rate by country

Source: OECD, Economix

Chart 10 NAIRU and long-term unemployment rate by countrySource: OECD, *Employment in Europe 1997*, *Employment in Europe 2009*, *Economix*

5. Assessment of approaches and conclusions

A changeful history

The research literature on the NAIRU and Okun's Law has a long and changeful history as Franz (2000) reports. Since the first evidence of a statistical correlation between inflation and unemployment was published by Irving Fisher in 1926 the issue disappeared for three decades. It revived as the famous Phillips Curve (1958), which not only became an important element of standard economic textbooks but was used broadly in daily debates on economic policies, by Keynesians in particular. In 1962 Arthur Okun published his article on "Potential GNP" where he developed his model for the correlation between output and unemployment.

With the neo-classical orientation of economics, however, the next downturn began. This was initiated by Lucas and Sargent who characterised the approach as an "econometric failure on a grand scale" (1978, p. 49). This was almost a knockout until Layard, Nickell and Jackman reanimated the NAIRU concept in their famous book on "Unemployment" (1991), emphasising the wish of being labelled neither Keynesian nor neo-classical (p. 11).

However, it became evident that there is not just one solution. Both the NAIRU and Okun's relation seemed to change over time, a fact that required new approaches. During the 1990s a series of empirical estimates were published trying to build adequate models and find improved measurement methods. Various filter techniques were used to find the optimal solution for the theoretical models, and estimation errors were quantified.

Nevertheless, at the end of the 1990s the assessment of the approaches still remained ambiguous: Stiglitz saw the NAIRU as a useful analytical approach (1997) while Galbraith questioned both its practical usefulness and its theoretical foundation (1997). Thus Franz concluded "There is nothing new on the NAIRU".

Okun's Law has meanwhile been adapted to the NAIRU approach and sophisticated statistical techniques were used to measure the relation. With limited success as the critics stated: the estimates remained uncertain and the famous relation turned out to be a rule of thumb rather than a law.

During the last decade the number of publications on both the NAIRU and Okun's Law has visibly decreased. There were some important efforts by the OECD to calculate the NAIRU for a series of OECD countries and to explain the differences between the outcomes. But the approaches obviously lost their attractiveness.

Simple relations but great confusion

Both approaches were trapped by their simplicity. They formulate basic macro-economic dependencies between inflation and unemployment by a few equations, or even one equation in the case of Okun's Law. A few parameters in the models have the task to capture all the important determinants of an economic system – and there are a lot of them:

- Monetary policy has a strong impact not only on inflation but on the real economy, thus affecting output and unemployment directly.
- Fiscal policy determines the tax wedge, affects prices and thus intervenes on both product and labour markets.
- Social policy determines the replacement rate of unemployment insurance and thus affects labour supply and the costs of labour.
- Industrial policy regulates many markets regarding size, scope and profitability. There are numerous direct links to prices and the volume of employment.

We can think of many more interventions which affect prices, wages and employment behaviour of an economy which are all exogenous to the models. The consequence is that the core parameters, the NAIRU and Okun's β reflect all these exogenous factors simultaneously – just like productivity which obstinately

refuses to be explained by econometric analysis. Such variables are catch-all figures which tell everything and nothing.

The OECD undertook valuable efforts to explain the country-specific differences of the NAIRU estimates and came up with the result that the main explanation lies in the unemployment benefit replacement rate and the trade union coverage. This is – to be polite – in line with the theory of sticky wages and prices, but – to be impolite – it is a tautology as the model exactly uses wage and price flexibility as determinants of unemployment. Thus we just know what the model assumes – in spite of the tremendous econometric efforts.

Merging all the determinants of inflation and unemployment has the advantage of building an average, a key figure for everything affecting this relation. If we restrain from explaining what the determinants are, the NAIRU describes the political or societal compromise between the devaluation of money and the non-utilisation of human resources. If we look at the history, the assessment of inflation and unemployment in the public has changed over time. The 1960s and 1970s were times when inflation was accepted as the minor problem compared to non-optimal growth. This changed radically with the price shocks of the two oil crises. They made unemployment to the socially accepted imbalance in economic development. In some countries, like Germany, this price stability driven consensus lasted until the middle of this decade while other countries, like the UK, switched to radical economic and labour market reforms during the 1980s. In this sense, the NAIRU appears to be a measure for the social compromise between money owners and workers. But don't we know this from other sources and do we need the quantification of this compromise without knowing where it's coming from? The information content of the NAIRU appears to be limited.

Moreover, new conflicts came up with climate change and environmental concerns. Thus policy has to consider more than just inflation and unemployment. If we take the modelling of this conflict as an important advantage of the NAIRU approach, it has to be extended to a broader description of principal trade-offs in economic development: growth and environmental sustainability, short-term flexibility and long-term efficiency, private profits and social returns, and many others. Only such a broad analysis of economic and social conflicts can avoid the shortcomings of the NAIRU and Okun's approach.

Uncertain estimates of transitory equilibria

It has to be appreciated that more recent publications undertook the effort to quantify estimation errors of the models. Depending on the methodology, country specificities, and data irregularities, the errors appear to be substantial – a fact that obliges all researchers to comment on the instability of their estimates and the limitations for cross-country comparisons. In principle only the basic relationships can be confirmed. This is better than nothing but not sufficient for an indicator which should be used for policy consulting purposes at the European level.

The reason for the instability of empirical estimates lies beyond econometric methods and data problems. It has to be searched for in the inadequacy of a simple macro-economic relationship which is given the task to reflect the behaviour of complex and heterogeneous systems. With millions of actors and thousands of markets, the expectation that a principal agent is able to describe systemic behaviour appears to be courageous if not absurd. In any case it neglects the fact that multiple equilibria might emerge at the same time on markets, or even in individual transactions. Disregarding this well-known critique of macro-economic approaches, the principal agent assumption is still regularly applied just by skipping the index of the individuals from a micro-economic equation (see e.g. Layard et al. 1991, p. 362).

Moreover in a dynamic world, equilibria exist for moments rather than periods. This is the reason why the NAIRU concept was first estimated as a time dependent variable in the 1980s. Obviously the theoretical constant was affected by a series of time variant factors which determine wage and price flexibility. Institutional settings, legal regulations and the behaviour of market participants change over time and require new solutions.

This raises the question of how to interpret the results of both approaches. Is the flattening of Okun's relation in 2009 a bad thing as it raises the employment threshold significantly, or is the labour hoarding practice of companies the right answer to the crisis? Is the reduction of the NAIRU in the UK a sign of the optimal alloca-

tion of labour or the rising marginalisation of the workforce? Does the stagnation of the NAIRU in Japan reflect a rigid labour market or does it result from administered labour supply policies? This list of contradictory interpretations is not exhaustive but already the few examples reveal the great difficulties with these approaches. Key indicators should always have a clear message. This is not the case.

Limited empirical information

The testing of the approaches with empirical data confirmed what the theoretical critique has identified.

The estimate of Okun's coefficient with a cross-country approach for 21 OECD countries revealed the expected negative correlation between growth and unemployment. However, the attempt to use the result for a year-on-year forecast of unemployment rates provided weak results. As the mean estimation errors equalled the variance of the actual change of unemployment rates, no information gain could be achieved. The coefficients calculated in this way do neither reflect the change of employer behaviour over the business cycle nor do they accurately represent the differences between countries. The estimation errors which appeared during the recent crisis are also caused by the disregard of working hours. This however is not just the problem of a missing variable. A theory of working time reactions would be needed in order to integrate these aspects.

The analysis of the NAIRU estimates in selected EU countries revealed the strong impact of both monetary policies and cyclical output fluctuations on actual inflation and unemployment rates. The traditional Phillips Curve approach is better visible than the NAIRU mechanism. The recent crisis underlined the strong importance of output fluctuations. While the NAIRU mechanism appears to be strongly policy driven, its links to specific policy measures remain speculative and vague.

The estimated NAIRU values thus remain a fiction which is based on the principles of neo-classical markets. Alternative assumptions on the long-term orientation of human capital decisions or the existence of money illusion, however, change the view on the underlying mechanisms completely. The NAIRU thus describes the systemic behaviour of an economy without defining a target value. Both low and high values appear to be plausible, depending on the theoretical view. For this reason, the usefulness of the NAIRU for evaluation purposes remains limited.

Complicated estimates with limited significance

The methodology applied nowadays for the NAIRU and Okun estimates are sophisticated and can only be used by experienced econometricians. This is not a principal barrier but determines the resources and the timing needed for the production of data. The OECD estimates were published with a two year lag and unknown resource inputs. This means that short-term observations are not possible, even if the input data are available in a monthly sequence.

The review of the OECD estimates reveals that the NAIRU values change rather slowly on an annual basis. The coefficient of variation for the years 2000-2007 is 4.7 % for the 17 countries observed. Considering the estimation errors for the NAIRU are far beyond this value, the indicators cannot be expected to describe changes of labour markets on a short-term basis.

Conclusions

The previous assessments lead to the result that the descriptive power, the explanatory power and the prospective power of the two indicators remain weak. No accurate and concise indication of labour market changes can be expected, and the outcomes open a wide range of interpretations. The theory behind the models appears to be limited compared to other macro-models. Obviously it is not possible to put the macro-economy into a nutshell.

There are better measures for wage and price flexibility than the NAIRU. There are better forecasts for labour demand and unemployment than Okun's relation. There are better descriptions of structural unemployment.

In the short-term the toolbox of European employment and labour market policy should rely on available macro-models which are able to reflect on a much wider scope of determinants and allow the effects of policy changes in many areas to be simulated. Moreover it can rely on the indicator sets available from business and labour market statistics. This provides a patchwork pattern of labour markets but nevertheless a more accurate description of its current state.

In the long-term, European labour market analysis should invest in research on heterogeneous systems which allow diverse behaviour, multiple equilibria, and dynamic processes to be considered. This requires new approaches to be developed which include psychological and sociological research. As the old economic theory is currently in a deep crisis, it is worth investing in new concepts rather than sustaining the old.

Annex

Annex I: Theoretical framework: Derivation of the NAIRU

Several textbooks give a comprehensive overview of the formal analysis and derivation of the NAIRU.³¹ As a basic consideration one has to take price and wage settings into account. Employees seek a higher real wage while employers' price decisions depend on unit labour costs. The level of unemployment influences the bargaining power of unions, which increases with low unemployment and decreases with high unemployment. Companies' price settings depend on the sales situation and thus on unemployment.³² Therefore, an equilibrium unemployment rate exists which balances wage and price claims. In this situation inflation is kept on a stable level. This unemployment rate is the NAIRU.

These considerations can be modelled by the following formulas:³³

The price setting equation illustrates that prices are set with a mark-up on the expected wages:

$$p - w^e = \beta_0 - \beta_1 u \quad \text{with } (\beta_1 \geq 0), \quad (1)$$

where p is the log prices, w^e the log of the wage expected by employers, and u defines the unemployment rate. β_0 and β_1 are the intersection and slope of the log-linear function.

Wages are set as a mark-up on expected prices, where the mark-up is higher if unemployment is low and vice versa:

$$w - p^e = \gamma_0 - \gamma_1 u \quad \text{with } (\gamma_1 \geq 0), \quad (2)$$

If the actual prices and wages are at their expected level ($p = p^e, w = w^e$), the NAIRU (u^*) is given by adding equations (1) and (2):

$$u^* = \frac{\beta_0 + \gamma_0}{\beta_1 + \gamma_1} \quad (3)$$

If actual values do not correspond with expected values of prices and wages, the unemployment rate is defined by:

$$u = \frac{\beta_0 + \gamma_0 - (p - p^e) - (w - w^e)}{\beta_1 + \gamma_1} = u^* - \frac{(p - p^e) - (w - w^e)}{\beta_1 + \gamma_1} \quad (4)$$

Assuming that the difference between expected and actual prices and wages is similar, equation (4) ends up in the following formula:

$$u - u^* = -\frac{1}{\theta_1} (p - p^e), \quad (5)$$

with $\theta_1 = (\beta_1 + \gamma_1)/2$.

If one supposes that inflation defined by Δp has no long-run trend and has a random walk with:

$$\Delta p = \Delta p_{-1} + \varepsilon,$$

where ε is white noise and Δ defines the change since the previous period, then the forecast of inflation is:

$$p^e - p_{-1} = \Delta p_{-1}.$$

³¹ These are, for example, Layard et al. (1991) Franz (1999) or Blanchard and Illing (2004)

³² Franz 1999 p. 362

³³ See Layard et al. (1991) pp. 13

This correlation defines in the consequence the difference between actual and expected values of prices as:

$$p - p^e = p - p_{-1} - \Delta p_{-1} = \Delta p - \Delta p_{-1} = \text{change in inflation.}$$

The equation above can explain the correlation between prices and inflation. An increase in the difference between actual and expected prices equals an increase in inflation. The same is true for wages. Equation (5) can thus be written as:

$$\Delta p - \Delta p_{-1} = -\theta_1(u - u^*), \quad (6)$$

which defines the expected-augmented Phillips Curve. If unemployment is higher than equilibrium unemployment, inflation decreases and vice versa. Thereby u^* can be interpreted as NAIRU.

Annex II: The different concepts of the NAIRU³⁴

For further estimations three different NAIRU's are used, differentiated by the time frame to which they relate. The short-run NAIRU was established in Annex I. Moreover, a NAIRU (without adjective) and a long-run NAIRU exist, both of which are deduced in the following paragraphs.

By extending the price setting equations with temporary and long-lasting influences, the new price setting equation can be written as follows:

$$p - w = \beta_0 + \beta_1 n + \beta_2 \Delta n - \beta_3 (p - p^e) - q + ZL_p + ZT_p \quad \beta_1, \beta_2, \beta_3 > 0 \quad (7)$$

where Δ is the first difference operator, n , w and p are the logarithms of employment, wage and prices, respectively. q represents the logarithm of trend labour efficiency, ZL_p is a vector of variables which have a long-lasting influence on the price setting (e.g. factors that affect the competitive structure or the cost of capital). ZT_p is a vector which represents variables that have a temporary influence on the price setting (e.g. supply shocks).

The wage setting equation will also be extended by long-lasting and temporary effects and thus changes into:

$$w - p = \gamma_0 - \gamma_1 u - \gamma_2 \Delta u - \beta_3 (w - w^e) + q + ZL_w + ZT_w \quad \gamma_1, \gamma_2, \gamma_3 > 0 \quad (8)$$

where ZL_w represents a vector of long-lasting effects on wage bargaining, for example relative bargaining power, mismatch between vacancies and job seekers, productivity growth or taxes. The vector ZT_w represents temporary factors that are affecting wage bargaining (e.g. supply shocks).

The labour supply is given by:

$$l = \alpha_0 - \alpha_1 u + ZL_l \quad \alpha_1 > 0 \quad (9)$$

with l representing the log labour force. For simplicity it is assumed that the labour supply is inelastic with respect to real wages. The labour force depends on the unemployment rate and other factors that influence the decision of participation represented by the vector ZL_l .

From the equations (7), (8) and (9) one can derive the equation for the long-run NAIRU (UL^*) when current and expected wages (prices) are met ($(w = w^e) = (p - p^e) = 0$), the unemployment rate is at a stable level ($\Delta u = 0$) and there are no temporary supply shocks ($(ZT_p = 0 \text{ and } ZT_w = 0)$). Moreover, the long-lasting effects have fully adjusted to their long-term equilibria ($ZL_p = zl_p$, $ZL_w = zl_w$ and $ZL_l = zl_l$).

$$UL^* = \frac{\delta_0 + \beta_1 zl_l + zl_w + zl_p}{\delta_1} \quad (10)$$

with $\delta_0, \delta_1 > 0$ as functions of the parameters β_s, γ_s and α_s . The long-run NAIRU depends on $zl_p, zl_w, zl_l, \delta_1$ and β_1 which means that it is affected by the main institutional characteristics of the product and labour market.

The NAIRU only differs from the long-run NAIRU by the supply factors not being at their equilibria but on their current level:

$$U^* = \frac{\delta_0 + \beta_1 ZL_l + ZL_w + ZL_p}{\delta_1} \quad (11)$$

³⁴ Richardson et al. (200), pp.30

Annex III: The NAIRU estimation approach of the Gianella et al. (2009) for 23 OECD countries

• First step: Estimation of the time-varying NAIRU

For the derivation of the estimation equation the augmented Phillips Curve framework is used as a basis. It is applied as a function of structural variables which affect the labour market and the product market in the long-run. The system of equations is the following:

$$\pi_t = \varphi(L)\pi_{t-1} - \beta(U_t - U_t^*) + \eta_W Z_t^{W,SR} + \eta_P ZP_t^{P,SR} \quad (1)$$

$$\text{with } U_t^* = \mu + \gamma c_K + \rho t_W + \theta_W Z_t^{W,SR} + \theta_P ZP_t^{P,SR}$$

where π_t is inflation, U_t the observable unemployment rate, and U_t^* the NAIRU. The variable $\varphi(L)$ is the polynomial function of the lag operator, c_K the real user cost of capital, and t_W the tax wedge. The variables $Z_t^{W,SR}$ and $ZP_t^{P,SR}$ are the vectors of long-lasting supply shocks which affect the wage-setting or price-setting mechanism, respectively.³⁵

In the first step, the time varying NAIRU is estimated by using the Kalman filter. In this context the NAIRU is treated as an unobserved stochastic variable and derived from the theoretical idea that the NAIRU is able to explain inflationary developments. With the Kalman filter technique, it is not necessary that all factors which affect the NAIRU are specified. NAIRU's time path is instead extracted from the Philips Curve equation (the so-called signal equation).

The Kalman filter is a common tool used to estimate equation systems which have time-varying parameters. To apply the Kalman filter the system of underlying equations has to be rewritten as "state-space model" with:

- a signal equation, also known as measurement equation (which is the Phillips Curve relationship)
- transition equations which specify the properties of the time-varying parameter (the NAIRU)

With the state-space model a recursive Kalman filter is defined from which a Maximum-Likelihood-estimator is derived. This means that the time-varying intercept (βU_t^*) is estimated with all other regression coefficients treated as constant (Franz 2003). The estimated term is then divided by the constant coefficient (β) of U_t which results in a time-varying NAIRU, U_t^* .

The augmented Philips Curve from equation (1), was specified by Gianella et al. (2009) as follows:

$$\Delta\pi_t = \sum_{j=1}^m \chi_j(L) \Delta\pi_{t-j} - \beta(U_t - U_t^*)$$

$$+ \sum_{j=0}^n \eta_j MGS_{t-j}^{SH} (\pi_{t-j}^{MGS} - \pi_{t-j}) + \sum_{j=0}^l \kappa_j OIL_{t-j}^{SH} (\pi_{t-j}^{OIL} - \pi_{t-j}) + v_t$$

Two types of short-term supply shocks were included. Firstly, an oil price shock from introducing the real oil price inflation (π^{OIL}), which was weighted by the oil intensity of production (OIL^{SH}), and the impact of trade and globalisation by including the real import price inflation (π^{MGS}) weighted by import penetration (MGS^{SH}). The number of lags (m , n , and l) was determined by starting with four lags and then by dropping insignificant lags. The variable v_t is the error term.

The transition equation for the NAIRU is determined as follows:

$$U_t^* = U_{t-1}^* + \varepsilon_t$$

³⁵ Long-lasting supply shocks change the NAIRU sustainably. These might be changes of the wage setting due to changes in the tax wedge, the bargaining power of unions or the average unemployment replacement rate, or price setting changes due to changes in the long-term interest rates or degree of monopoly in specific industries.

where the error term ε_t is normally distributed and uncorrelated with v_t from the Phillips Curve equation. It is commonly assumed that the NAIRU follows a random walk.

As a transition equation for the unemployment gap the following equation was defined:

$$U_t - U_t^* = \psi(L)(U_{t-1} - U_{t-1}^*) + \zeta_t$$

where the error term ζ_t is normally distributed and not correlated with ε_t .

For the application of the Kalman filter, initial conditions of the time-varying parameter and the smoothing parameters need to be determined: To pre-specify the assumptions for the values and variances of the NAIRU and the unemployment gap, a maximum likelihood approach was used to determine a prior for the initial values. For the NAIRU, this value equals the average unemployment rate in the first year of the sample period and for the unemployment gap it equals the difference between the unemployment rate in the first year and the prior of the NAIRU. The variances of residuals are fixed in empirical applications.³⁶

- *Second Step: Estimation of the indicators driving the NAIRU*

The impact of determinants on the NAIRU was estimated using a first difference model in order to control unobserved specific fixed effects and to transform the variables of interest into stationary processes. For the determinants the current and lagged values (Ω) were included:

$$\Delta \hat{U}_{it}^* = \sum_j \sum_k \alpha_{ijk} \Delta \Omega_{ijt-k} + w_{it}$$

where i is the country index, t the time index, and j an institution index, meaning that Ω_{ijt} is the value of institution j in country i at time t . The number of lags k is dependent on the institution or the country, respectively.

In order to avoid potential endogeneity biases between institutions and policies, the equation was estimated by using instrumental variables. These were the lagged levels of explanatory variables.

³⁶ See Gianella et al (2009), pp. 11-12, no. 17

Annex IV: Estimation results of the NAIRU estimation by the OECD

Table 12 Estimation results for the time varying NAIRU

Country	Average 1970-74	Average 1975-79	Average 1980-84	Average 1985-89	Average 1990-94	Average 1995-99	2000	2001	2002	2003	2004	2005	2006	2007
Austria	1.1	0.9	2.1	3.5	4.4	4.8	4.8	4.9	4.9	5.0	5.0	4.9	4.9	4.9
Belgium	3.5	5.2	7.0	7.9	8.0	8.2	8.1	8.0	8.0	8.0	8.0	8.0	8.0	8.0
Denmark		4.3	6.1	6.4	7.1	5.9	5.1	5.0	4.9	4.9	4.7	4.6	4.4	4.2
Finland	3.8	2.4	3.1	4.8	9.1	11.5	9.6	8.6	8.1	7.7	7.6	7.5	7.4	7.0
France	3.1	4.4	6.7	8.4	9.2	9.7	9.0	8.7	8.6	8.6	8.6	8.6	8.5	8.3
Germany	1.9	3.1	4.8	6.1	6.8	7.8	8.0	8.1	8.2	8.4	8.5	8.7	8.6	8.4
Greece		3.0	5.4	7.3	8.4	9.8	10.6	10.6	10.6	10.4	10.4	10.2	9.9	9.8
Ireland			13.0	15.3	14.0	9.8	6.6	5.9	5.5	5.2	5.0	4.8	4.7	4.7
Italy	5.6	5.6	6.3	8.7	9.2	9.6	8.9	8.6	8.3	7.9	7.4	7.0	6.6	6.4
Japan	1.7	1.8	2.2	2.6	2.9	3.6	4.0	4.1	4.1	4.2	4.1	4.1	4.1	4.0
Luxembourg			1.1	1.5	2.0	2.8	4.1	4.0	3.8	3.8	3.7	3.6	3.6	3.5
Netherlands	2.8	3.4	5.9	7.1	6.5	5.3	4.3	4.1	3.9	3.9	3.9	3.8	3.8	3.8
Portugal			7.3	6.8	6.1	6.0	5.8	5.9	6.1	6.3	6.5	6.7	6.8	6.9
Spain			8.6	13.4	14.4	13.5	5.1	5.0	5.0	5.0	5.1	5.1	5.1	5.1
Sweden	2.3	2.5	2.9	3.3	4.4	5.1	5.1	5.0	5.0	5.0	5.1	5.1	5.1	5.1
UK	4.6	5.9	9.0	9.7	8.8	7.3	6.1	5.8	5.6	5.4	5.3	5.3	5.3	5.3
US	5.5	6.2	6.5	6.4	6.0	5.5	5.3	5.3	5.3	5.2	5.2	5.1	5.1	5.0

Gianella 2009, p.41, Economix

Annex V: Real GDP and the change of unemployment for selected countries

Table 13 Real GDP growth and change of unemployment rate by country

Country	year	Real GDP (% change from previous year)	Change of unemployment rate ¹ (change from previous year)
Austria	2008	1.9	-0.6
	2009	-3.8	1.0
Belgium	2008	0.8	-0.4
	2009	-3.1	0.8
Denmark	2008	-1.2	-0.4
	2009	-4.5	2.7
Finland	2008	0.8	-0.4
	2009	-6.9	1.8
France	2008	0.3	-0.5
	2009	-2.3	1.7
Germany	2008	1.0	-1.1
	2009	-4.9	0.2
Greece	2008	2.0	-0.6
	2009	-1.1	1.8
Ireland	2008	-3.0	1.8
	2009	-7.5	5.5
Italy	2008	-1.0	0.6
	2009	-4.8	1.0
Japan	2008	-0.7	0.1
	2009	-5.3	1.1
Netherlands	2008	2.0	-0.4
	2009	-4.3	0.7
Portugal	2008	0.0	-0.4
	2009	-2.8	1.9
Spain	2008	0.9	3.1
	2009	-3.6	6.7
Sweden	2008	-0.4	0.1
	2009	-4.7	2.2
UK	2008	0.6	0.3
	2009	-4.7	1.9
US	2008	0.4	1.2
	2009	-2.5	3.5
Euro Area	2008	0.5	0.1
	2009	-4.0	1.9
¹ OECD Harmonised unemployment rate			

Source: OECD Economic Outlook 2010, Economix

Literature

Akerlof, G. A. and R. J. Shiller (2009), "Animal Spirits – How Human Psychology Drives the Economy, And Why It Matters For Global Capitalism", Princeton University Press.

Ball, L. and G. Mankiw (2002), "The NAIRU in Theory and Practice", Harvard Institute of Economic Research Discussion Paper No. 1963.

Beveridge, S. And C. R. Nelson (1981), "A New Approach to Decomposition of Economic Time Series into Permanent and Transitory Components with Particular Attention to Measurement of the 'Business Cycle'", Journal of Monetary Economics, vol. 7, issue 2, pp. 151-74. [\[web\]](#)

Blanchard O. and G. Illing (2004), "Makroökonomie", 3rd. Edition, Pearson.

Chang R. (1997), "Is Low Unemployment Inflationary?", Economic Review, Federal Reserve Bank of Atlanta, First Quarter 1997.

Fabiani, S. and R. Mestre (2004), "A system approach for measuring the euro area NAIRU", Empirical Economics, vol. 29, no. 2, pp. 311-41.

Fabiani S. et al. (2005), "The pricing behaviour of firms in the Euro area. New survey evidence", European Central Bank, Working Paper No. 535.

Fisher, I. (1926), "A Statistical Relationship between Unemployment and Price Changes", International Labour Review, vol. 13, no. 6 (June), pp. 785-92.

Franz W. (1991, 1999), "Arbeitsmarktökonomik". 4. Auflage, Springer Verlag.

Franz W. (2000), "Neues von der NAIRU? ", ZEW Discussion Paper 00-41 [\[web\]](#).

Franz, W. (2003), "Will the (German) NAIRU Please Stand up?", ZEW Discussion Paper No. 03-35. [\[web\]](#)

Layard R., S.Nickell and R. Jackman (1991, 2005), "Unemployment: Macroeconomic Performance and the Labour Market", Oxford University Press.

Lee, Jim (2000), "The Robustness of Okun's Law: Evidence from OECD Countries", Journal of Macroeconomics, vol. 22, no. 2, pp. 331-56.

Galbraith, J. K. (1997), "Time to Ditch the NAIRU", Journal of Economic Perspectives, Vol. 11, No. 1 (Winter) 1997, pp. 93-108.

Gianella et al. (2009), "What Drives the NAIRU? Evidence from a Panel of OECD Countries", OECD Economic Department Working Paper No. 649. [\[web\]](#)

Gordon, R. J. (1997), "The Time Varying NAIRU and its Implications for Economic Policy", Journal of Economic Perspectives (winter), pp. 11-32.

Gordon, R. J. (1984), "Unemployment and Potential Output in the 1980's", Brookings Papers Economic Activities, vol. 15, pp. 537-64.

Hodrick, R. J. and E. C. Prescott (1997), "Post-War U.S. Business Cycle: An Empirical Investigation", Journal of Money, Credit and Banking, vol. 29, issue 1, pp. 1-16. [\[web\]](#)

Knoester, A. (1986), "Okun's Law Revisted", Weltwirtschaftliches Archiv, vol. 122, no.4, pp. 657-66.

Knotek, E. S. II (2007), "How Useful is Okun's Law?", *Economic Review*, vol. 2007, Q IV, pp. 73-103.[\[web\]](#)

Lucas, R. E. and T. J. Sargent (1978), "After Keynesian Macroeconomics", Federal Reserve Bank of Boston, *After the Phillips Curve: Persistence of High Inflation and High Unemployment* (Boston (Conference Series No.19)), pp.49-72.

Malley J. and H. Molana (2008), "Output, Unemployment and Okun's law: Some evidence from G7", *Economics Letters*, vol. 101, pp. 113-15.

Mc Adam, P. and K. Mc Marrow (1999) "The NAIRU Concept – Measurement, Uncertainties, Hysteresis and Economic Policy Role". ECFIN Economic Paper No. 136.[\[web\]](#)

Mc Marrow, K. and W. Roeger (2000) "Time-Varying NAIRU/NAWRU Estimates for the EU's Member States". ECFIN Economic Paper No. 145. [\[web\]](#)

Moosa, I. A. (1997), "A Cross-Country Comparison of Okun's Coefficient", *Journal of Comparative Economics*, vol. 24, no. 3, pp. 335-56.

Nishizaki, F. (1997), "The NAIRU in Japan: Measurement and its Implications", OECD Economics Department Working Paper No. 173.

Okun, A. (1962), "Potential GNP: Its Measurement and Significance", American Statistical Association, *Proceeding of Business and Economics Statistics Section*, pp. 331-56.[\[web\]](#)

Orlandi, F. and K. Pichelmann (2000), "Disentangling Trend and Cycle in the EUR-11 Unemployment Series: An Unoverserved Component Modelling Approach", ECFIN Economic Paper No. 140.[\[web\]](#)

Phillips, A. W. (1958) "The Relationship between Unemployment and the Rate of Change of Money Wages in the United Kingdom 1861-1957". *Economica* 25 (100): 283–299.

Richardson et al. (2000) "The Concept, Policy Use and Measurement of Structural Unemployment: Estimating a Time-Varying NAIRU Across 21 OECD Countries". OECD Economic Department Working Papers No. 250.[\[web\]](#)

Samuelson, P. and R. Solow (1960), "Analytical Aspects of Anti-Inflation Policy", *The American Economic Review*, vol. 50, no. 2, *Papers and Proceedings of the Seventy-Second Annual Meeting of the American Economic Association*, (May, 1960), pp. 177-194.

Schalk, H. J., J. Lüschoff and G. Untiedt (1997), "Wachstum und Arbeitslosigkeit – Gibt es noch einen Zusammenhang", *Ifo Schnelldienst*, 50. Jahrgang, no. 17-18, pp. 3-14.

Sögner, L. and A. Stiassny (2002), "An Analysis on the Structural Stability of Okun's Law – A Cross-Country Study", *Applied Economics*, vol. 14, pp. 1775-87.

Staiger, D, J. H. Stock, and M. W. Watson (1997), "The NAIRU, Unemployment and Monetary Policy", *The Journal of Economic Perspectives*, Vol. 11, No. 1, (Winter) 1997

Stiglitz, J. (1997), "Reflections on the Natural Rate Hypothesis", *Journal of Economic Perspectives*, vol. 11, no.1, pp. 3-10.

Stephanides, G. (2006), "Measuring the NAIRU: Evidence from the European Union, USA and Japan", *International Research Journal of Finance and Economics*, Issue 3.[\[web\]](#)

Weber, C. E. (1995), "Cyclical Output, Cyclical Unemployment, and Okun's Coefficient: A New Approach", *Journal of Applied Econometrics*, vol. 10, issue 4, pp. 433-45.[\[web\]](#)

Yazgan, M. E. and H. Yilmazkuday (2009), "Okun's convergence within the US", *Letter of Spatial and Resource Sciences*, vol. 2, no. 2-3, pp. 109-22.

Zellner, A. (1962), "An Efficient Method of Estimating Seemingly Unrelated Regressions and Tests for Aggregation Bias", *Journal of the American Statistical Association*, vol. 57, pp. 348-68.