Have Europe's Labour Markets Become More Flexible?

An Exercise in Measuring the Relative Flexibility of Wages across Countries and Time*

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Abstract: It is a curiosity of economic analysis that achieving structural reform and wage flexibility has become the chief preoccupation of the European policy; yet there are no firm estimates of the degree of wage flexibility in the literature, nor of how much it differs between countries or whether it has been increasing over time and the impact of monetary union. At best we have anecdotal evidence, and arguments going back to the Delors Report which stress the need for wage and price flexibility. This paper sets about analysing wage flexibility in Europe at different frequencies, across different countries and at different moments of time (including after the single currency). We find that, contrary to popular wisdom, the US markets do not have greater flexibility in a general sense. But it does have less wage persistence and greater flexibility at the business cycle frequency, and short run flexibility may have been increasing relative to the long run persistence in wages. Eurozone wages, by contrast, are more persistent, and show short term spurts of higher flexibility which are not sustained. Moreover, since 1998, wage flexibility in Europe has slumped in what looks like "reform fatigue" once countries were safely inside the Euro.

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1. Introduction

Wage and price flexibility, and the structural and institutional reforms required to induce this kind of flexibility, have now become the leading economic issue in Europe. This is not a new development. It has long been argued that structural reforms were a necessary condition for a successful monetary union (Delors, 1989). Nor has this gone unrecognised within Europe itself. The Lisbon Agenda, agreed in 2000, was introduced precisely to create greater market flexibility.

Yet not much has happened. Few reforms have been carried out, and anecdotal evidence suggests that there is little wage and price flexibility in either the Eurozone as a whole or in its larger or more influential members. The sluggishness of the German, French and Italian economies, and their difficulty in generating growth and jobs over the past three years, stand witness to that. It is almost as if they thought that once inside the relatively closed European economy, they did not have to worry about reform and flexibility; the competitive pressures of the outside world (including the new member states in Central and Eastern Europe) would be shielded from them. Yet since the Eurozone economies appear to have less flexible markets than their American or Asian counter-parts, policies to restore economic performance to US and Asian levels have become more and more focussed on the need to generate higher productivity, lower costs and (above all) flexibility in the labour markets.

This view is typically derived from the analytic and empirical evidence of a negative link between economic performance and (real) wage rigidity across many countries (Bruno, 1986)[1]. The same link has been found in the labour and the product markets in Europe (Koedijk and Kremers, 1996), and in the transition economies (Kaminski et al., 1996), where performance is measured in rates of growth and employment; and where deregulation/flexibility is reflected in competition policy, merger codes and the liberalisation of employment and wage bargaining practices. For the non-members and some of the periphery economies, this rapidly becomes a question of

[1] The link is usually made with real wage rigidity, but in an era of low inflation (and in the Eurozone in particular with its common monetary policy) real wage rigidity will be approximately synonymous with nominal wage rigidity. Since the latter is more transparent and easier to measure accurately, we investigate the flexibility of nominal wages in this paper.

whether they would ever want to join, or remain in, a union of economies less flexible than themselves.[2]

The purpose of this paper is to consider how one might set about measuring the degree of wage flexibility in an economy. Despite the concern about wage flexibility, there are no serious estimates in the literature, no accepted methodology for making such estimates, and little more than anecdotal evidence of the “greater than”, “less than” kind. We therefore investigate the degree of wage flexibility in a sample of European countries, in particular at the business cycle frequency. We then examine, first, whether flexibility differs across countries (is it lower in the core economies like France, Germany, Italy? and higher in the smaller economies like Finland, Austria or Ireland?). Second, we ask if it is really higher in countries outside the Euro? And, third, whether the degree of wage flexibility has been increasing over time, especially after the increased market pressures with the coming of the Euro. Or has joining the Euro reduced the incentive and perceived need for the kind of reforms that would produce greater labour market flexibility, similar to the “reform fatigue” which appeared in the attempts at fiscal consolidation after 2000? If the latter were true, it would go a long way to explain why labour market reforms are often discussed and advocated in Europe – but so seldom undertaken. The fate of Harz IV in Germany, the new labour laws in France, and pension reform in Italy are just three of the most obvious examples of that pattern of behaviour.

2. Methodology

2.1 The Analytic Background

While there is little disagreement that monetary union and structural reforms are linked, those links are clearly not well understood. For example, the Delors Committee (1989) stressed the importance of parallelism in the monetary and economic spheres in such a union, but took the view that economic structures were exogenous and could only be changed through policy reform. Policy reforms, rather than market structures, are therefore seen as necessary to ensure that economic developments are flexible across

[2] See Hughes Hallett (2003), Hughes Hallett (2003), Hughes Hallett et al. (2005).

member states. Others, for example Frankel and Rose (1998), argued that these structures themselves will be endogenous. If so, the need for reform is less obvious. The necessary flexibility might materialise anyway, simply as a consequence of unification. In that spirit, Andersen et al (2000) have found that monetary integration in Europe is changing labour market structures and inducing some wage convergence, but only on a very small scale. In fact, Saint-Paul (2004a, b) argues that, due to political constraints and special interests, these changes in behaviour are really only visible in Ireland. In addition, Hughes Hallett and Piscitelli (2002) have shown that convergence through greater market flexibility may not happen in volatile economies; or where there are differences in industrial structure; or where a lot of integration has already taken place.

By contrast, two papers by Calmfors (1998; 2001) make the point that although money-wage flexibility is likely to be larger inside a union such as the Eurozone, labour market reforms are less likely to be implemented if the motive for that union was to solve a time-inconsistency problem. If true, this would suggest that we will find "reform fatigue" after 1998, and declining flexibility. But Sibert (1999) and Sibert and Sutherland (2000) argue that asymmetric shocks will modify that conclusion since countries will find it more necessary to develop measures against such shocks to replace their ability to adjust by changing exchange rates. But that would mean that, given an economy with less than average distortions, the partners will face an incentive either to reform themselves; or to encourage the flexible economy to converge on their less flexible market practices. In a world of political and financial costs to reform, and where there are special interests to reform and the use of fiscal policy is limited, it is clear which way the argument will go and it will not be in the direction of altruistic reforms.

2.2 Our Estimation Technique

We identify wage flexibility as the ability to vary the growth in wages with different frequencies of intervention – and at the business cycle in particular. Many studies have attempted to capture the variability of a particular variable at different frequencies, that is the weight of the different cycle lengths in its evolution, and the natural way to do it would be to use spectral analysis since that decomposes the overall variability in a series into the components due to each of the cycles present in the data. The appendix to this paper sets out how we can best do that in the presence of structural breaks and comparatively short spans of data.

Most cyclical analysis in economics has been concerned with assessing the correlations between national business cycles, and has therefore used simple correlation techniques which average across all the cyclical components (frequencies) once the raw data has been detrended to provide the underlying variations. The results of that approach have been very mixed. For example, Mankiw et al. (1992), Dowrick and Nguyen (1989), Barro and Sala-I-Martin (1991; 1992), Quah (1993) find evidence of convergence for a sample of OECD countries at similar level of development over the years 1960-1985, but reject it for a wider sample of 75 economies whose development varies rather more. In contrast, Chauvet and Potter (2001) report that the US business cycle was in line with the G7 from the mid 70s, but then diverged thereafter. Stock and Watson (2002; 2005) likewise find divergence in individual cases caused by structural breaks, but convergence on average at the world level.

As far as the Eurozone is concerned, Frankel and Rose (1998) and Prasad (1999) argue that if exchange rates are pegged and trade links intensify, business cycles are likely to converge. But Inklaar and de Haan (2000) and Baxter and Kouparitsas (2005) find no evidence of a corresponding convergence among the OECD economies (see also: Doyle and Faust, 2003; Kalemli-Ozcan et al., 2001; Peersman and Smets, 2005). All these results suggest a time-varying approach is going to be necessary if we are to analyse any cyclical properties in economics[3]. Indeed new evidence suggests that the NAIRU is not constant, therefore calling for time-varying estimators such as the Kalman Filter (Driver, 2006; Grant, 2002). We therefore go back to the more direct approach of spectral analysis, and show how this can be adapted to produce time varying spectra in which the flexibility of wages is displayed at each frequency or cycle length.

A second point is that the correlation studies cited above also make it clear that variance decompositions will be sensitive to: a) the choice of correlation measure; b) the

[3] It appears that cyclical properties may also change with the degree of industrial specialisation which is increasing with trade and financial links (Kalemli-Ozcan et al, 2003).

choice of cyclical measure (classical or growth cycles); and c) the detrending measure (linear, Hodrick-Prescott filter, band pass etc.). This sensitivity is a problem emphasised by Canova (1998). The advantages of using our time-frequency analysis are:

i) It does not depend on any particular detrending technique, so we are free of the lack of robustness found in many studies.

ii) Our methods also do not have an "end-point problem" – no future information is used, implied or required as in band-pass or trend projection methods.

iii) There is no arbitrary selection of a smoothing parameter, such as in the HP algorithm, equivalent to an arbitrary band-pass selection (Artis et al., 2004).

However, any spectral analysis technique is tied to a model based on a weighted sum of sine and cosine functions. That is not very restrictive. Any periodic function may be approximated arbitrarily well over its entire range, and not just around a particular point, by its Fourier expansion (a weighted sum of sine and cosine terms) – and that includes non-differentiable functions, discontinuities and step functions. Hence, once we have time-varying weights (the time-frequency approach) we can get almost any cyclical shape we want. For example, to get long expansions, but short recessions, we need only a regular business cycle plus a longer cycle whose weight increases above trend but decreases below trend (i.e. varies with the level of activity). This is important because many observers have commented on how the shape of economic cycles has changed over time in terms of amplitude, duration and slope (Harding and Pagan, 2001; Peersman and Smets, 2005; Stock and Watson, 2002). A time-varying spectral approach is necessary to provide the flexibility to capture these features. Similarly it is necessary to accommodate, and reveal the possibility of structural breaks which must be expected with the operation and breakdown of the EMS, the coming of the Euro, the changes in monetary institutions, and the increasing integration and volatility of financial markets.

3. The Empirical Evidence on Wage Flexibility

To illustrate the degree of wage flexibility, and how it may have changed in the recent past, we have applied our time-frequency estimation techniques to the wage data of twelve countries in and outside the Eurozone. We start with data on average nominal wages and salaries, economy-wide, for each country starting in 1977 and finishing in 2001.[4] That data is converted to annual growth rates by computing

$$y_t = \Delta \log(Y_t) = \log(Y_t / Y_{t-1}) \quad (1)$$

where Y_t = total wages and salaries paid in a given economy in period t. The data is differenced and therefore stationary.[5]

Our data is taken from the OECD's *STAN Data Base*; and our sample of countries includes the US (a benchmark, representing the popular view of an economy with flexible wages and labour market institutions); then Germany, France, Italy, Austria, Belgium and the Netherlands to represent the core of the Eurozone; Spain, Ireland and Finland representing the more successful countries in the periphery; and finally the UK, Denmark and Norway as countries that have chosen to remain outside the Eurozone.

3.1 Statistical Results

As Table 1 below shows, the estimation results led to an AR(2) model at the first stage of calculating national spectra for wages and salaries in each country. The fact that the same order of AR model was found in each case was coincidental, but not unexpected given that we are working with annual data and that wage contracting means that the bulk of wages and salaries are renegotiated and agreed on a 1-2 year schedule in most countries.[6] However, to be sure of this specification, we started with a higher order AR(p) scheme with p=8 and progressively reduced the order of each national model by eliminating insignificant coefficients on a general to specific basis, until we had both white noise errors and a maximum information criterion (the Aikike criterion, AIC) using the procedures described in the appendix. Each time series model therefore satisfies a full set

[4] Data limitations forced us to start in 1984 for France, 1983 for Austria, and in 1981 for Finland. This maintains compatibility in wage data used. However the sample can be extended to 2005 in five cases.
[5] ADF and Philips-Perron tests of stationarity in the resulting series for each country are available upon request.
[6] Denmark required an AR(3) model to satisfy all the specification and diagnostic checks listed below. Given the results cited in the appendix, this means Denmark does not have the potential to converge on the other countries in our sample in terms of labour market behaviour, whereas the others could converge.

of diagnostic tests and provides a model which is stationary with white noise residuals and lowest AIC value. It has also been validated in terms of stationarity, statistical significance, parameter variation and specification checks using the Ploberger et al. (1989) and LaMotte-McWorther (1978) structural break tests noted in the Appendix.

- Table 1 about here -

Having thus obtained a time varying AR(2) model in each case, we *calculate* the short-time Fourier transform as defined in the Appendix and determine the corresponding time-varying spectrum from there. The results are displayed in figures 1-13; and a series of summary statistics derived from those spectra, designed to highlight the relative degrees of short and medium term wage flexibility in each country, are set out in table 2.

3.2 The Benchmark and Benchmark Indicators of Wage Flexibility

Conventional wisdom takes the US, and the recently reformed economies such as the UK or Ireland, to be prime examples of economies with a fair degree of short term wage flexibility – sufficient at least to enjoy higher rates of growth than the other OECD economies, at lower rates of inflation and unemployment, for the past two decades. One might surmise that this flexibility has allowed these economies to maintain a lower natural rate of unemployment without inflationary pressures than the others, and empirical estimates tend to support that conjecture (Driver (2006), Laubach (2001)). However we are not concerned with natural rates of unemployment here, but with the short run ability of wages to adjust around it so as to maintain unemployment close to its equilibrium level, or possibly around a lower equilibrium.

We therefore take the US case, in figure 1 and table 2, to be our benchmark. We then compute the other countries by group, using indicators of short run flexibility of wages growth compared to the US. The country groups are:

a) The core members of the Eurozone (the most converged);

b) “Periphery” countries, also members of the Eurozone;

c) The non-members: those who have elected not to join but remain members of the European Union or with formal trade agreements with the EU (the “outs”).

We take the power of the wages spectrum at business cycle frequencies or higher to be the natural indicator of the flexibility or adjustability of wages (whether correctly applied or not), and the power of the same spectrum at low frequencies as a natural measure of the persistence in wages growth. Ideally there should be greater power at the business cycle frequencies or higher; but low power at the lower frequencies. That would imply flexible wages. Unfortunately this is not what we find, even in the US. Typically the balance of power goes the other way, with low power at high frequencies and higher power at low frequencies[7]. However, this effect is not very marked in the US. So we need to add two qualifications. Where spectral power is distributed evenly across time (at each frequency band), an economy has not been tested by shocks or regime changes. In that case we cannot say if wage flexibility exists, only that it has not been used. But this does not happen in our data. Conversely, if the spectral density is distributed evenly across all frequency bands for a certain period, then flexibility is at least as important as persistence and may be high or low depending on the level of wage variability indicated.[8]

Accordingly, Table 2 provides a set of wage flexibility indicators calculated from figures 1-13. The first two columns show the relative power of the wages spectrum (variability of wages) at short cycles, compared to the power of the same spectrum at low frequencies. This ratio gives a measure of the importance of high frequency, rapid adjustments to the growth of wages, compared to the importance of the persistent or slowly adjusting elements. In practice this means comparing the power of the wages spectra at high frequencies (frequency 2.7) with that for low frequency adjustments (frequency band 0.1-0.2). To that we add the power of the wages spectrum at the business cycle length (frequency band 0.9 – 1.1) relative to the variability of US wages at the same frequency; and also the ratio of the power of the domestic wages spectrum at low frequencies to that for US wages in the same band. These figures appear in column three, and allow a comparison of wage flexibility and wage persistence in the medium and longer term (relative to the US). Finally, we report the power of the wages spectrum at its peak to give an idea of the overall persistence or adjustability in wages (column 4).

[7] With the exception of Germany, Austria and Norway since 1993, Denmark since 2002, and the UK, Spain and Italy for a limited period in the 1990s: see figures 1-13.
[8] The US, Netherlands and Finland show this in the later 1990s.

The remaining four columns have to do with how and when the degree of wage flexibility has changed. They show how much flexibility has been lost since its peak by 2001, or the since start of the Euro. They also show when the peak flexibility and period of least flexibility occurred (in the interval since 1977).[9]

- Table 2 about here –

4. The US Wages Spectrum and an Overview of the Results

At first sight it appears that the US, contrary to expectation, is actually *less* flexible (in wages) than many of her European counterparts. And in some respects this is true. But on closer inspection, it appears that the US does have more flexible wages growth in certain important respects. The persistence in US wages is uniformly lower; and the apparent flexibility in Europe is a result of efforts made to prepare those economies for entry into the Euro was a temporary phenomenon which didn't last. In fact, the increased flexibility of the mid to late 1990s had vanished, almost entirely, by 2000-04.

In fact the US shows a general level of flexibility which is as high as the main players in the Eurozone at business cycle lengths (the Netherlands excepted), even if it is less than that in the periphery or non-members. The difference is that flexibility in the US is fairly uniform across time and frequencies, whereas in the core Eurozone countries it is very variable – increasing at certain times, but then rapidly diminishing again (compare figure 1 with figures 2-7). As a result the persistence indicators are lower in the US, and the flexibility to persistence ratios higher than in most of the Eurozone economies, although the peak periods in Europe have provided greater wage flexibility for a time.

But that extra flexibility in Europe does not last very long, and the short to long run ratios soon revert to levels similar to or lower than those in the US – and particularly in the period after qualifying for the Euro in 1997-98. It is as if the Eurozone members had got reform and wage flexibility fatigue once they were safely inside the Euro and could relax under the protection of the relatively closed and disciplined Euro-economy.

[9] Note that, for several countries, peak flexibility was in the 1980s but there have been secondary (and often temporary) peaks in the late 1990s while countries qualified for the Euro. See the notes to table 2.

One can see this by comparing the dates of peak flexibility, the losses in flexibility since then, and the dates of the least flexibility over the entire sample. In the Eurozone, peak flexibility appears in the run up to joining the Euro (except in the reform economies, Spain and Ireland). And the losses in flexibility since that time are twice as large as those in the US or non-members. Moreover, the period of least flexibility always appears after the Euro regime had started (2000-4). This “reform fatigue” phenomenon should appear familiar. Exactly the same thing happened to the fiscal reforms, and the debt and deficit consolidations, after entry into the Euro was secure (Hughes Hallett and Lewis, 2006). Once the sanction of not qualifying for the Euro was lifted, market discipline appers to have been abandoned – at least relative to that in the US.

There is another way in which the results are different in the US. Underlying wage flexibility may now be greater in the US because, apart from the temporary increases in Europe, it has been increasing in the US but decreasing in much of Europe. As a result, the ratio of short run flexibility to long run persistence in wages has risen between the 80s and 90s in the US (along with Spain, Germany and Ireland). But is has fallen, and often significantly, in the other European economies. As a result, the US now shows less wage persistence than the European economies and as much wage adjustment at the business cycle frequencies as the core Eurozone economies. This, after all, is the frequency at which wage flexibility is most needed to stabilise the economy around its equilibrium and to help markets adjust to changing demand and supply conditions.

5. Country by Country Results:

a) The US. The US economy is distinguished by having, relative to Europe, rather little difference between short run and long run wage variability. It is therefore characterised by a combination of wage flexibility in the traditional sense, and a lesser amount of wage contracting (long run persistence). On average, and certain peaks apart, this leaves the US economy with as much or more wage flexibility as her principle European counterparts – particularly at the crucial business cycle frequencies. Moreover, that flexibility appears to have been slowly increasing over time, in contrast to Europe, and to have suffered no decline in the late 1990s. There is also a period of marked flexibility in 1986-91 which lays the groundwork for that economy's success in the subsequent decade. Nevertheless, the structural break tests indicate that these changes are statistically insignificant. Indeed, we could not find any change of the dynamic behaviour of the growth rate of wages over the sample period.

- Figure 1 about here -

b) The Eurozone's Core Economies. The core EU economies appear to divide into two camps, those who have attempted to reform (Germany and the Netherlands) and those who have not (the inner core: or France, Italy, Belgium and Austria).

The inner core countries, particularly France, Austria and Belgium show both low flexibility overall and declining relative flexibility (Table 2). Peak flexibility for these economies appears to have been in the mid-1990s, at the point of qualifying for the Euro. Germany, by contrast, has gone through a period of remarkable transformation and structural change from 1990 to 1994 when the relentless persistence in her wages growth was shifted to create some flexibility at the business cycle frequency. That flexibility has declined by more than half since then, but it remains larger than in other core economies. This shift reflects the impact of her reunification, and stands in contrast to the inner core economies where the increased flexibility has been concentrated around preparations for joining EMU and was a temporary state of affairs (most clearly seen in Italy and Austria). After 1998-9, the gains were almost totally wiped out again in a return to the status quo ante. These economies seem to have felt no need for reform once safely in the Euro.

- Figure 2 about here –

France has followed this pattern, but with some reductions in long run persistence, lower average flexibility and only token increases in flexibility before joining the Euro. For her, the period of structural changes starts *after* that in Germany (from 1994 – 1996).

- Figure 3 about here –

The Italian spectrum appears to be similar to the German wages spectrum. However, one big difference is that the dynamic behaviour of Italian wages growth reverted to its pre-EMU pattern in 1998. In that sense, Italy has proved to be the most inflexible country.

- Figure 4 about here-

At times the Austrian spectrum has shown a lot of power at business cycle frequencies, but this power is always short lived and has largely vanished since the start of the Euro. However the fluctuations test reveals these changes to be too brief to be statistically significant, and at other times there is little variability in wages at all.

- Figure 5 about here -

In terms of the smaller economies, the Belgian spectrum is the most volatile. It is also different in shape in that, like France, all the power is at long cycles (at frequencies of 0.1 to 0.5). But unlike France, the wage persistence that this implies is not decreasing over time. And, again like France, there is little evidence of any serious attempt to create more medium term flexibility in wages.

- Figure 6 about here -

The Netherlands, rather like Austria, displays rather little flexibility on average but has the ability to create extra flexibility when it is needed. The labour and social reforms, and change in strategy of the Lubbers government in 1983-86 is very clear to see. Likewise, the changes on entering the Euro and in response to the 2003-4 recession also stand out. But the economy appears to have had difficulty in sustaining these changes for any length of time ("old habits die hard"). Nevertheless Dutch wages show a lack of persistence, and the scale change shows that the Netherlands had more flexibility in wage setting than the inner core countries, Austria, or Germany, in the same way that the US does.

- Figure 7 about here -

c) Periphery Countries. There are clear differences from the core countries here. The periphery countries have greater flexibility on average, and at the business cycle length, *and* significantly less long run persistence in wages growth. They also have short run to long run flexibility ratios that increase rather than decrease. Nevertheless the fluctuations tests do not detect any structural changes. So overall the spectra remain stable and flat, apart from periods of reform in the 1980s. Spain is the exception, with flexibility appearing at the business cycle frequency in the 1990s in preparation for the Euro. The Spanish spectrum therefore looks like the German wages spectrum, except that the extra flexibility of the 1990s appears to have been lost again by 2003.

- Figure 8 about here -

- Figure 9 about here -

- Figure 10 about here -

Hence, like the core economies, these economies have suffered "reform fatigue" and a similar loss of wage flexibility: less so in Spain, but more clearly in Finland and Ireland where the effects of the Soviet collapse and the transition to a catch-up regime (respectively) are especially clear to see. All three have also profited from the single market, having had their period of greatest flexibility in the 1980s or early 1990s.

d) Non-members ("outs"). In terms of wage flexibility, these three economies, the UK, Denmark and Norway, occupy a position somewhere between the US and the more successful Eurozone economies. But they are probably more similar to the US. All three have higher short run flexibility on average, and at the business cycle frequency.

- Figure 11 about here -

- Figure 12 about here -

- Figure 13 about here -

All three also show rising ratios of short run flexibility to wage persistence, as in the US, although they have more wage persistence. And all three, like the US, show no decline in wage flexibility at the end of the 1990s after the Euro was introduced – the apparent loss in business cycle flexibility in Denmark and the UK in 2000-01 having been recovered almost entirely by 2003. The UK, Denmark and Norway therefore still show the effects of the market liberalisation achieved after the days of inflexibility in the 1980s.

6. Conclusions

In this paper we have introduced a new technique for measuring the degree of wage flexibility in an economy. It is a remarkable thing that we have spent a great deal of time stressing the importance of wage flexibility (and the market reforms needed to create it), particularly in the European context where rigidities are considered high and a common monetary policy has reduced the options for non-market adjustments; when we have so few measures of wage flexibility in practice, or of how it compares to countries outside the Eurozone. A good part of the Lisbon Agenda is devoted to the problem of flexibility and reform, yet our supporting evidence remains anecdotal. This paper is intended to go some way to closing that gap.

Having made some preliminary estimates of wage flexibility in the European economies, it is obvious that the degree of flexibility is a more subtle concept than traditional analyses would lead us to believe. Blanket statements, such as "the US is a more flexible economy", and "the Eurozone should reform to achieve similar degrees of market flexibility" mean very little. The US is not obviously more flexible in many respects. But it is more flexible in a number of particular ways; and it has held on to its greater flexibility better. Indeed our results suggest the US may have now increased her flexibility advantage over the EU, due to "reform fatigue" in Europe.

From the empirical results, it is clear that wage flexibility is also an elusive concept. It is far from constant over time or groups of countries; and it may vary a great deal at different cyclical frequencies. The Eurozone economies have shown rather little flexibility in the core, but rather more in the periphery and smaller economies. They now probably have less flexibility than the US at the crucial business cycle frequency. More important, they have shown greater wage persistence; and some have a downward trend in relative flexibility (as measured by short run variability relative to long run persistence). Finally, they have all shown an ability to create greater flexibility when times are bad, but they have been equally unable to hold on to that flexibility thereafter. As a result, the degree of short run wage flexibility has fallen by as much 100%-150% since qualifying for the Euro, and wage flexibility is now lower than during the 1990s. That suggests "reform fatigue" has set in, similar to the consolidation fatigue that appeared in fiscal policies once inside the Eurozone.

In contrast to this, the non-member countries have shown similar degrees of flexibility to the US, and a smaller tendency to lose that degree of flexibility with the passage of time. Perhaps being small, open and exposed to world competition creates a greater sense of the need for market discipline.

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Tables and Figures

Table 1: Estimation by Kalman filter

Country	Dependent Variable	Annual data from	Usable observations	Degree of Freedom	Sum of squared residuals	R-square	Akaike Info Criterion	Ljung-Box Test: Q=	Coefficients[1]				
									constant	Lag1	Lag2	Lag3	t
France	dlfrw	1979 - 2001	20	17	9.799e-07	0.9985	3.595e-06	5.8	0.01123 (0.00067) 16.8	0.61734 (0.17) 3.54	0.1938 (0.27) 0.7	_	_
Germany	dlgerw	1971-2001	28	25	3.0482e-04	0.802	8.4387e-04	4.8	0.03649 (0.04065) 0.89782	-0.11797 (0.37592) -0.31382	0.38508 (0.15351) -2.67601	_	_
Italy	dlitaw	1971-2001	28	24	5.7646e-06	0.9982	1.9139e-05	8.7	0.14626 (5.1e-05) 2867.25	0.33895 (0.0804) 4.0784	-0.2825 (0.1922) -1.4699	_	-0.0031 (0.00047) -6.667
Austria	dlausw	1977-2002	23	19	4.6942e-07	0.9988	1.7224e-06	10	0.05073 (7.14e-05) 710.29	0.20014 (0.98373) 0.20345	-0.49457 (0.21198) -2.33325	_	-0.00066 (0.00034) -1.93867
Belgium	dlbelw	1971-2005	32	28	7.0204e-08	0.9999	2.0264e-07	4.95	0.012336 (0.000116) 106.5602	0.54588 (0.01124) 47.7486	0.54041 (0.16014) 3.44108	-0.35699 (0.44891) -0.79524	_
Netherlands	dlnethw	1971-2005	32	29	2.0149e-06	0.9977	4.4842e-06	10.4	0.0361312 (0.012719) 2.840753	0.356014 (0.07226) 4.926946	-1.38112 (0.71358) -1.93549	_	_
Spain	dlspw	1971-2005	32	28	1.6390e-06	0.9989	4.7308e-06	12.3	0.0972703 (0.000239) 406.6763	0.306715 (0.15418) 1.98928	-0.28425 (0.18895) -1.50439	_	-0.00086 (0.00132) -0.65206
Ireland	dlirew	1978-2005	25	22	4.9939e-06	0.9925	1.4129e-05	12	0.0275184 (0.001325) 20.76336	0.650375 (0.24709) 2.63212	0.37582 (0.32056) 1.17238	_	_
Finland	dlfinw	1976-2002	25	21	9.7327e-09	0.9998	3.7921e-08	3.3	0.07245 (1.19e-07) 609986.15	0.445214 (0.14694) 3.02988	-0.21413 (0.31081) - 0.68895	_	-0.00185 (0.00088) -2.11142
UK	dlukw	1971-2005	32	29	1.5887e-06	0.9989	3.81109e-06	16	0.036436 (0.02246) 1.622163	0.42645 (0.08925) 4.77825	-0.19067 (0.0934) -2.0407	_	_
Denmark	dldenw	1971-2005	32	28	3.3368e-08	0.9999	9.63136e-08	9.8	0.002375 (6.18e-06) 384.51	0.62852 (0.0262) 23.9576	-0.5182 (0.2959) -1.7513	0.65452 (0.5153) 1.27026	_
Norway	dlnorw	1971-2000	27	23	8.2916e-06	0.9918	2.89405e-05	8.4	0.093975 (0.000435) 215.84	0.5396 (0.14295) 3.42782	-0.3535 (0.1383) -2.5558	_	-0.00141 (0.00125) - 1.12693
US	dlusw	1971-2001	28	24	1.9892e-05	0.9623	6.60431e-05	13.7	0.07721 (0.009449) 8.1710	0.19418 (0.04317) 4.49836	0.036093 (0.0917) 0.39367	_	-0.0023 (0.0006) -3.7357

Note: 1. Coefficient columns contain the estimated parameters (line 1), followed by standard errors in parentheses (line 2) and t-statistics (line 3).

Table 2: Comparing Wage Flexibility, the Summary Statistics

Country	Power SR/LR mid1980s	Power SR/LR mid1990s	Flexibility, persistence rel. to US [a]	Flexibility: power at bus. cycle peak	Power lost by 2001 [e]	Peak flexibility [c]	Least flexibility [d]	Structural Breaks
a) Core								
France	0.07	0.10	0.45 (1.2)	0.040	130%	1996	1989-90	1994-1996
Germany	0.56	1.00	3.0 (1.4)	0.190	58%	1993	1990-91	1990-1994
Italy	0.38	0.57	1.1 (1.2)	0.075	88%	1997	1998-2001	none
Austria	0.75	0.75	0.8 (1.0)	0.025	310%	1994,1997	1999,2000	none
Belgium	0.33	0.33	0.43 (2.3)	0.085	300%	1998	1992,2001	1987-89,1995,1998,2002
Netherlands	0.70	0.75	5.7 (0.5)	0.280	140%	1998,2004	1999-2001	1989-1990,1997,1999-01
b)Periphery								
Spain	0.35	0.60	2.3 (2.0)	0.12	52%	1994,1996	2000,2004	none
Ireland	0.23	0.40	1.4 (2.8)	0.12	120%	1987-1991	1997,2004	none
Finland	0.60	0.30	1.0 (2.0)	0.60	500%	1993	1995,2000	1993,1994-1998
c)Nonmembers								
UK	0.30	0.43	1.5 (1.5)	0.075	33%	1996,2001	1980,1997	1986-1989,2000
Denmark	0.25	1.00	0.9 (1.7)	0.061	100%	1994	1997-01	1993-1997
Norway	0.17	0.35	1.2 (1.0)	0.070	25%	1979,1988	1981-87	none
d)Benchmark								
US	0.63	0.70	1.0 (1.0)	0.043	30%	1990	1977	none

Notes:

a) Ratio of flexibility of domestic wages to US wages at business cycle frequency in 1997 (ratio of the persistence in domestic wages to the persistence of US wages at long cycle frequencies, 0.1, in 1997). The latter rises significantly after 1997, the former typically falls.

b) Norway, Denmark, the UK, Finland, Spain, Austria, Germany and perhaps the Netherlands have the greater wage flexibility at business cycle frequencies, than persistence at long cycles or flexibility at short cycles. These are the countries known to have undertaken reforms in the labour markets since 1992 or earlier, and does not include those economies in transition or in a catch-up phase.

c) Additional periods of high flexibility: France 1991, 1993; Germany 1999; Austria 1987,1995; Belgium 1984; Netherlands 1983,1986; Spain 2001-04; Finland 1991-92; UK 1990-95; Denmark 2002-05.

d) Other periods of special wage rigidity: Germany 1977-80; Italy 1980-85; Belgium 1988-93;Spain 1989-91,2005; Ireland 1992-96; Finland 1994-95; UK 1977-80, 1997-02; Denmark 1977-92.

e) Power (flexibility) lost since the peak at the business cycle frequency. Flexibility lost since joining EMU: France 130%, Italy 88%, Austria 310%, Belgium 300%, Netherlands 140%, Spain 12%, Ireland, Finland, and Germany 0%.

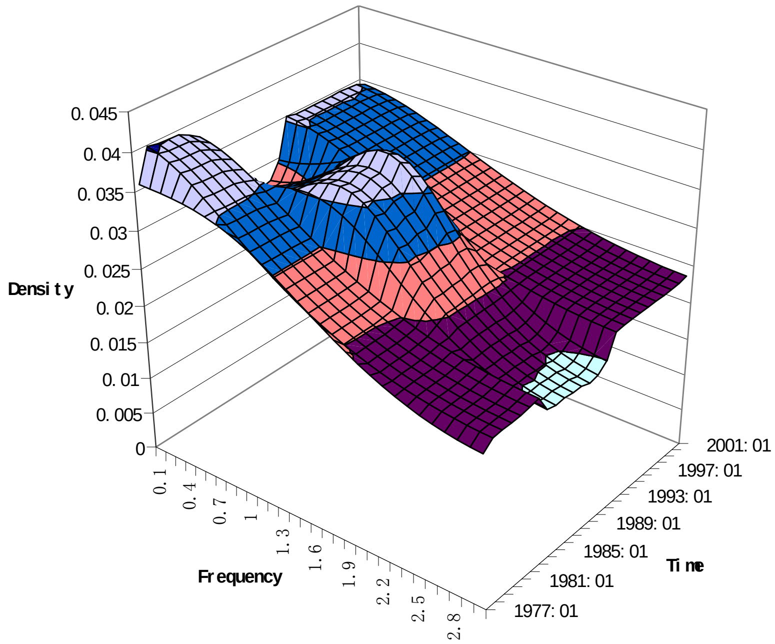

Figure 1: US Spectrum

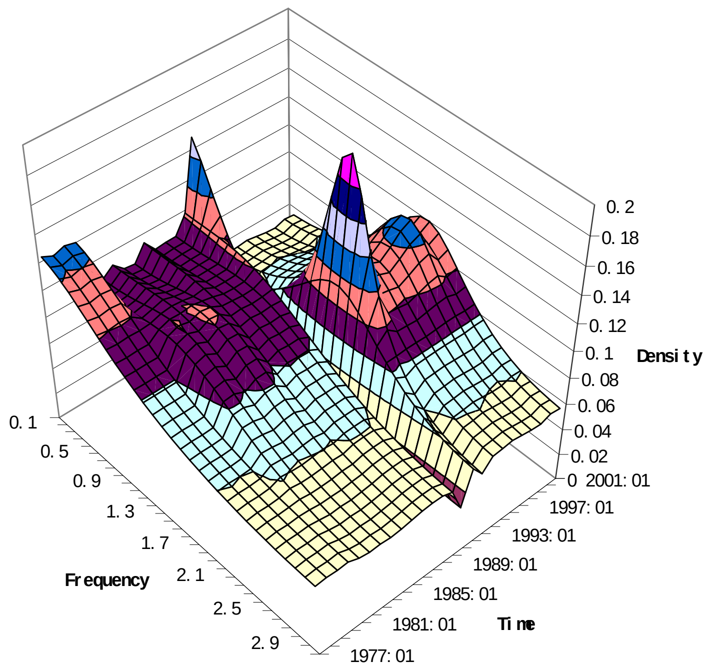

Figure 2: The German Spectrum

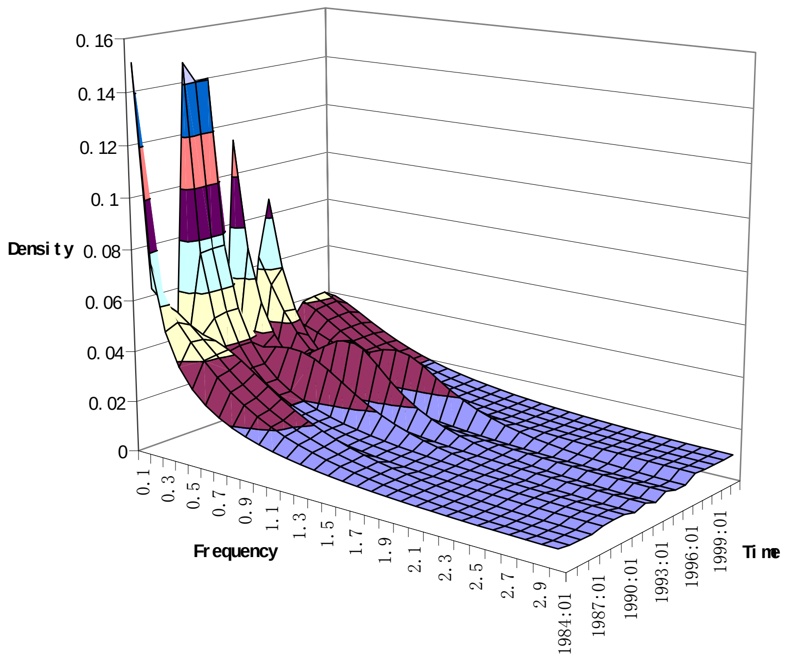

Figure 3: The French Spectrum

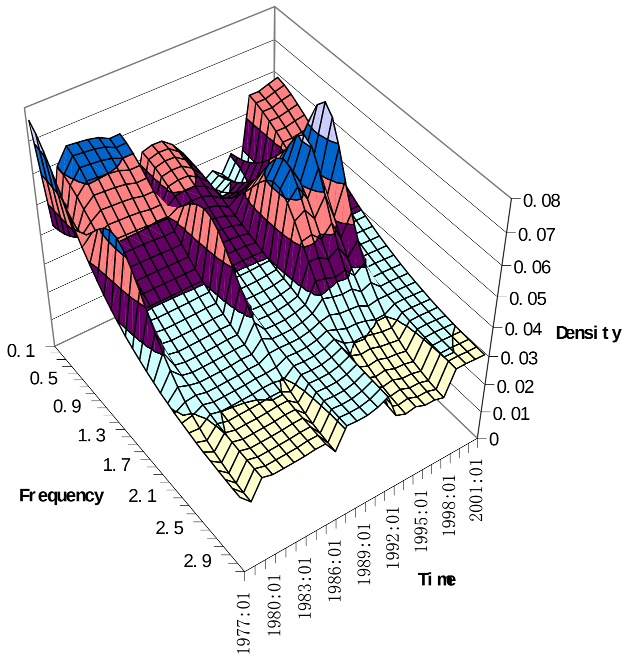

Figure 4: The Italian Spectrum

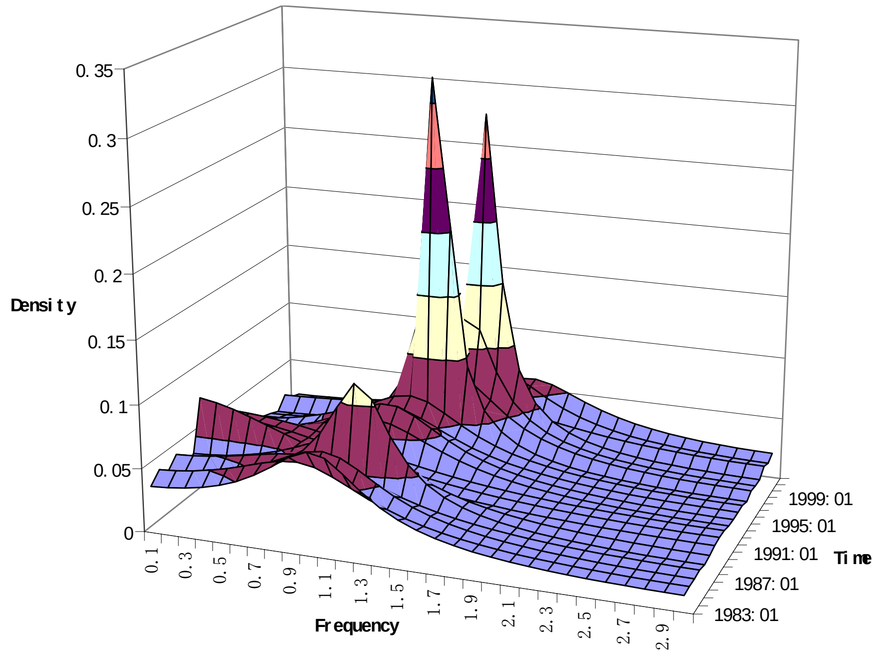

Figure 5: The Austrian Spectrum

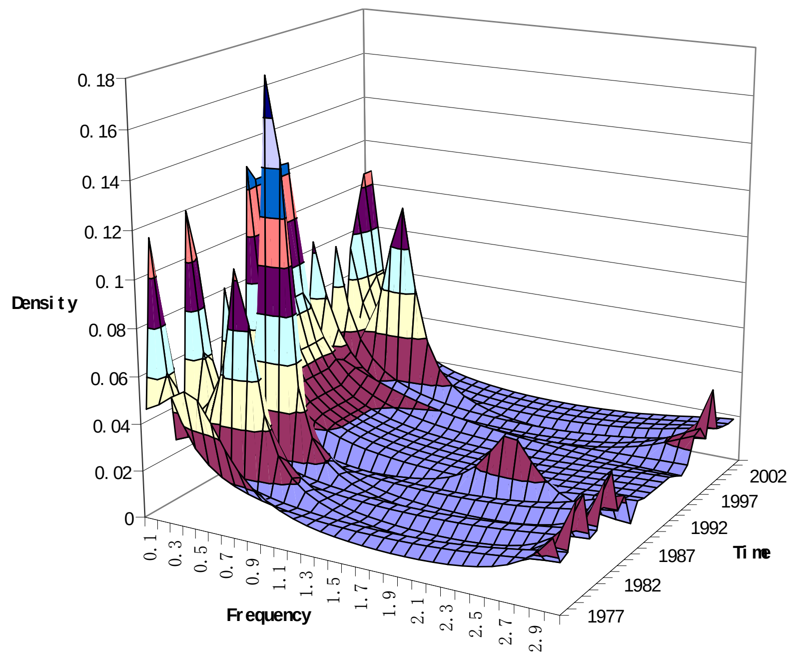

Figure 6: The Belgian Spectrum

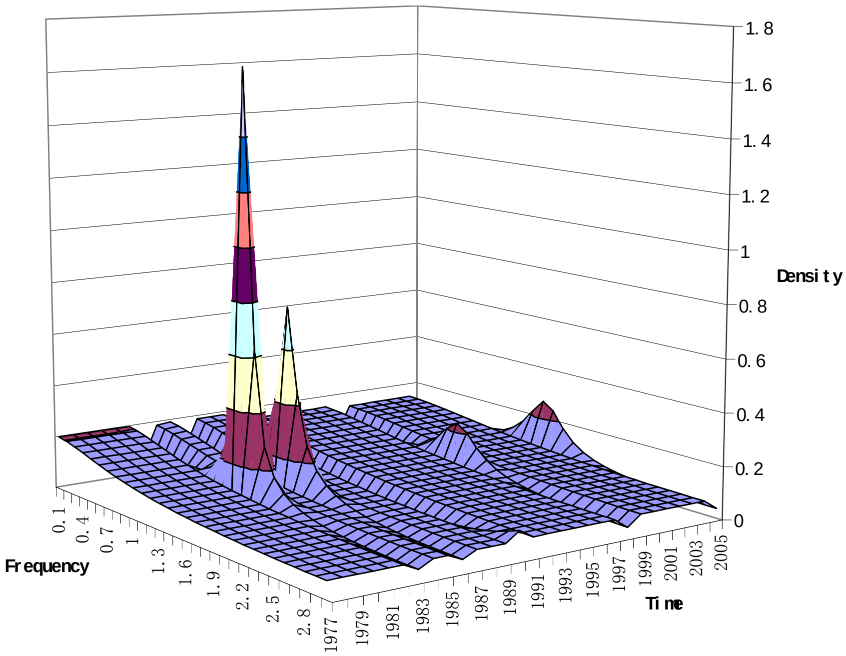

Figure 7: The Dutch Spectrum

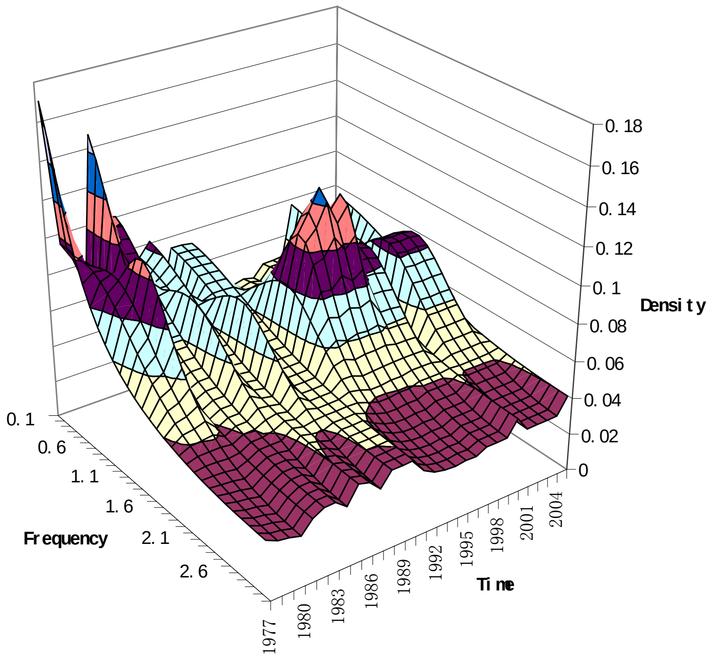

Figure 8: The Spanish Spectrum

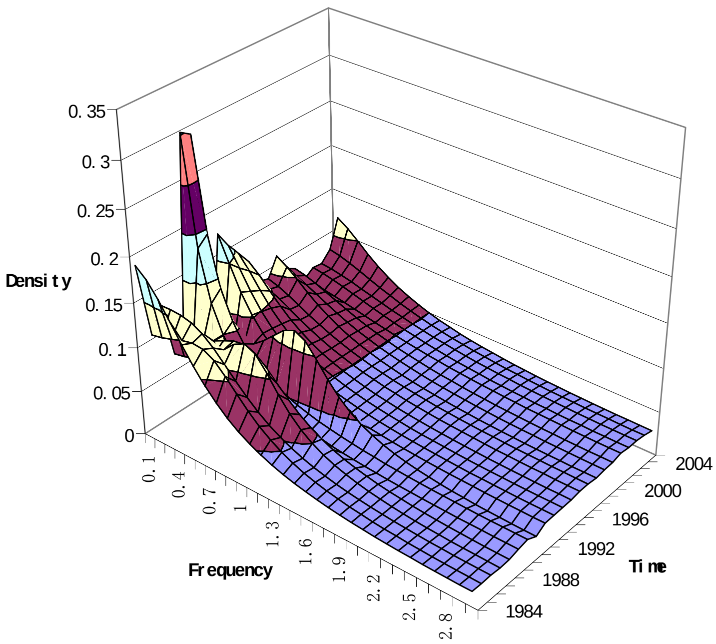

Figure 9: The Irish Spectrum

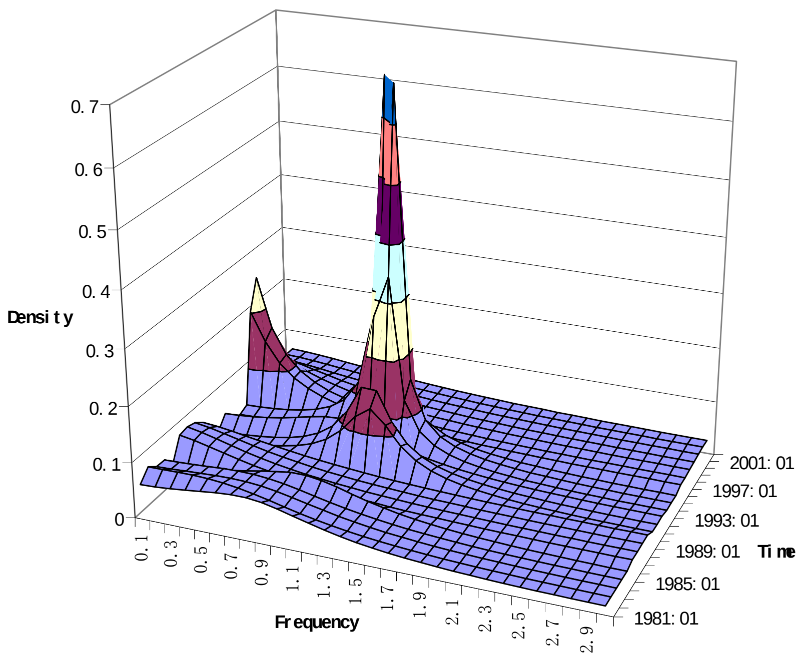

Figure 10: The Finnish Spectrum

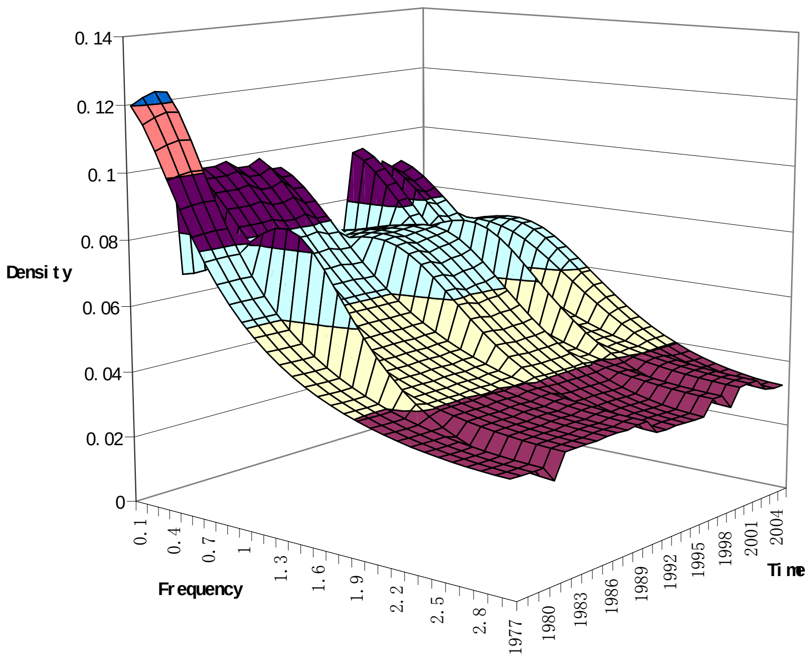

Figure 11: The UK Spectrum

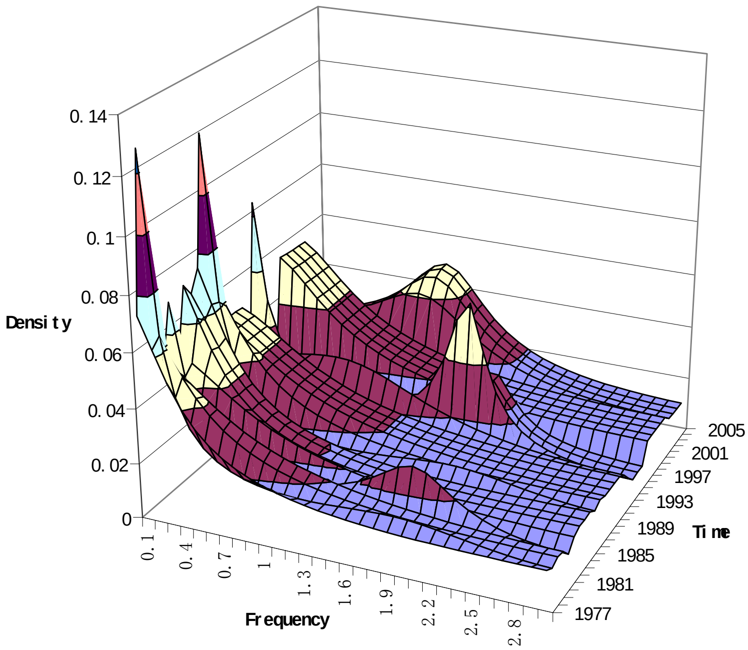

Figure 12: The Danish Spectrum

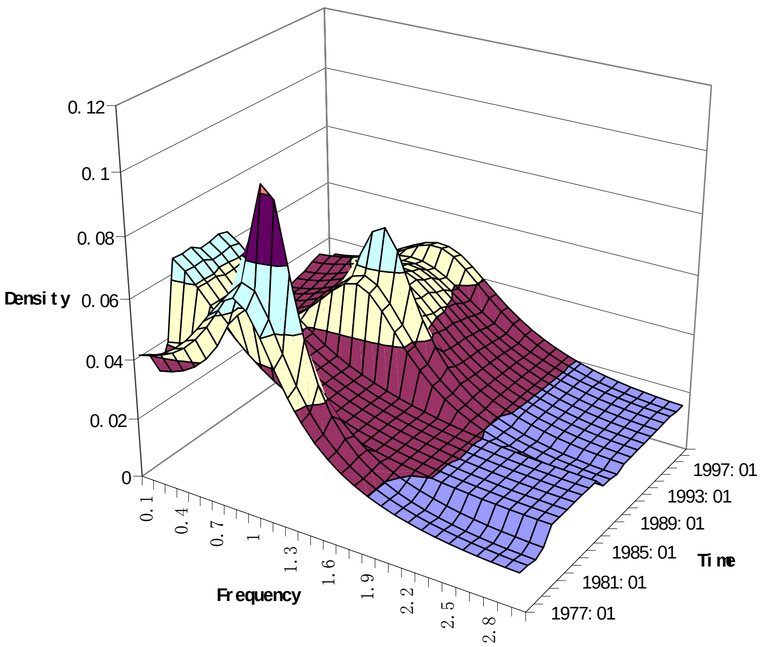

Figure 13: The Norwegian Spectrum

Appendix: Time Frequency Techniques and the Estimation of Time Varying Spectra or Cross-spectra.

Spectral analysis decomposes the variance of a sample of data across different frequencies. The power spectrum itself then shows the relative importance of the different cycles in creating movements in that data, and hence describes the cyclical properties of a particular time series. It is assumed that the fluctuations of the underlying data are produced by a large number of elementary cycles of different frequencies. Furthermore, it is usually assumed that the contribution of each cycle is constant throughout the sample. However, as Chauvet and Potter (2001) show in the US economy, business cycles cannot always be assumed to be constant.[10] In such cases, the spectrum would not be constant over time due to the changing weights associated with each of the elementary cycles. A "traditional" frequency analysis framework cannot handle that case. But in recent years *time-frequency techniques* have been developed which can do so. They depend on using a Wigner-Ville distribution for the weights (see for example: Matz and Hlawatsch, 2003). In this paper we make use of a special case of the Wigner-Ville distribution, known as the "short time Fourier transform" (STFT) in the engineering literature. The STFT catches structural changes (here interpreted as changes of the underlying lag structure in accordance with Wells, 1996), but assumes local stationarity.

[10] Hughes Hallett and Richter (2006) contain further illustrations of the time-varying nature of business cycles in Europe and the US.

We employ the STFT for two reasons: first, the time series we analyse are already in log-differenced form (see eq. (1) above) so stationarity may safely be assumed. Moreover, standard unit root tests performed on our data (specifically the ADF and Phillips-Perron tests, results available on request) confirm that assumption. Finally, the available results on macroeconomic output data (Campbell and Mankiw, 1987; Clark, 1987) also confirm that conclusion. Secondly, if the time series is stationary, then the STFT and the Wigner-Ville distribution actually coincide (Boashash, 2003). Hence, employing the Wigner-Ville distribution directly would not have changed our results at all.

a) The Initial Time Series Model: As indicated in the text, all the data collected are for nominal wages and salaries from the OECD's *STAN Data Base*. It is annual data from 1977 to 2004. Annual growth rates in wages and salaries are then defined as:

$$y_t = \Delta\left(\log\left(Y_t\right)\right) = \log\left(\frac{Y_t}{Y_{t-1}}\right) \tag{A.1}$$

Next we employ a two step procedure. As Evans and Karras (1996) point out, if two cycles are to converge, implying similar degrees of wage flexibility at each frequency, they have to follow the same AR(p) process. We therefore estimate an AR(p) process for each growth rate individually. But, to allow for possible changes in the parameters, we employ a time-varying Kalman filter model to estimate the chosen AR(p) model:

$$y_t = \alpha_{0,t} + \sum_{i=1}^{9} \alpha_{i,t} y_{t-i} + \varepsilon_t \tag{A.2}$$

with

$$\alpha_{i,t} = \alpha_{i,t-1} + \eta_{i,t}, \text{ for i=0...9} \tag{A.3}$$

and $\varepsilon_t, \eta_{i,t} \sim \text{i.i.d.}\left(0, \sigma^2_{\varepsilon,\eta_i}\right)$, for i=0...9

In order to run the Kalman filter we need initial parameter values. These initial parameter values can be obtained estimating them by OLS across the entire sample (see also Wells, 1996)[11]. Given those starting values, we can now estimate the parameters of (A.2) using a Kalman filter estimator. To do this, we employed a general to specific approach, eliminating insignificant lags using the strategy specified below. The maximum number of lags was determined by the Akaike Criterion (AIC), and was found to be two in each case (Denmark excepted). Each time we ran a new regression we used a new set of initial parameter values. Then, for each regression we applied the set of diagnostic tests reported in Table 1 above, in order to confirm the specification found. The final parameter values are filtered estimates, independent of their start values.

[11] Obviously, using the entire sample implies that we neglect possible structural breaks at this stage. The initial estimates may be biased therefore. However, the Kalman filter will then correct for this since, as Wells (1996) points out, the Kalman filter will converge to the true parameter value independently of the initial values. But initial values which are already "close" to the true value accelerate convergence. Hence we employ an OLS estimate to start. In fact, we find those start values to have no effect on the parameter estimates by the time we get to 1990. Hence our results are robust.

b) Specification Tests and Parameter Significance: The specification search above implies that we will get parameter values for each point in time. A particular parameter could therefore be significant for all points in time; or at some time periods but not others; or it might never be significant. The parameter changes are at the heart of this paper as they imply a change of the lag structure and a change in the spectral results. We therefore employed the following selection strategy. If a particular lag was never significant, then this lag was dropped from the equation and the model was estimated again. If the AIC criterion was less than before, then that lag was completely excluded. If a parameter was significant for some periods but not others, it was kept in the equation with a parameter value of zero for those periods in which it was insignificant. This strategy allowed us to minimise the AIC criterion, and leads to a parsimonious specification of the time series model. Finally, we tested the residuals in each regression for auto-correlation and heteroscedasticity.

The specification (A.2)-(A.3) was then *validated* using two different stability tests. Both tests check for the same null hypothesis, in our case a stable AR(2) specification, against alternative temporal instabilities. The first is the fluctuations test of Ploberger et al. (1989), which detects *discrete* breaks at any point in time in the coefficients of a possibly dynamic regression. The second test is due to LaMotte and McWorther (1978), and is designed specifically to detect *random* parameter variation of a specific unit root form (our specification). We found that the random walk hypothesis for the parameters was justified for each country (results available on request). Finally, we chose the fluctuations test for detecting structural breaks because the Kalman filter allows structural breaks at any point and the fluctuations test we use is able to accommodate this.[12] Thus, and in contrast to other structural stability tests, the fluctuations test is not restricted to any pre-specified number of breaks.[13]

Once this regression is done, it gives us a time-varying AR(p) model. From this AR(p) we are able to *calculate* the short–time Fourier transform, as originally proposed by Gabor (1946), to determine the corresponding time-varying spectrum. We briefly introduce the STFT here: for details, the reader is referred to Boashash (2003). The basic idea is to find the spectrum of a signal x(t), at time t, by analysing a small portion of the signal around that time.

c) Spectral Estimation: Consider a signal $s(\tau)$ and a real, even window $w(\tau)$, whose Fourier transforms are S(f) and W(f) respectively. To obtain a localised spectrum $s(\tau)$ at time $\tau = t$, we multiply the signal by the window $w(\tau)$ centred at time $\tau = t$. We obtain

$$s_w(t,\tau) = s(\tau)\, w(\tau - t) \qquad \text{(A.4)}$$

[12]Note that all our tests of significance, and for significant differences in parameters, are being conducted in the time domain *before* transferring the results into the frequency domain, because no statistical tests exist for calculated spectra (the transformations are nonlinear and involve complex arithmetic). Stability tests are important here because our spectra are potentially sensitive to changes in the underlying parameters.

[13] The fluctuations test works as follows: one parameter value is taken as the reference value, e.g. the last value of the sample. All other observations are now tested whether they significantly differ from that value. In order to do so, Ploberger et al. (1989) have provided critical values which we have used here. If the test value is above the critical value then we have a structural break: the parameter value differs significantly from the reference value and vice versa. Given the Kalman filter, these tests can be conducted sequentially.

We then calculate the Fourier transform w.r.t. τ which yields

$$F_s^w(t,f) = \underset{\tau \to f}{\mathcal{F}}\left\{ s(\tau)\, w(\tau - t) \right\} \tag{A.5}$$

$F_s^w(t,f)$ is the STFT. It transforms the signal into the frequency domain across time. It is therefore a function of both. Using a bilinear kernel and a Gabor transform (the time series is stationary, but may contain parameter changes), Boashash and Reilly (1992) show that the STFT can always be expressed as a time-varying discrete fast-Fourier transform calculated for each point in time. That has the very convenient property that the "traditional" formulae for the coherence or the gain remain valid, but will have to be recalculated at each point in time. The time-varying spectrum of the wages growth series can therefore be calculated as (see also: Lin, 1997):

$$P_t(\omega) = \frac{\sigma^2}{\left| 1 + \sum_{i=1}^{9} \alpha_{i,t} \exp(-j\omega i) \right|_t^2} \tag{0.1}$$

where ω is angular frequency and j is a complex number. The advantage of this method is that, at any point in time, a power spectrum can be calculated instantaneously from the updated parameters of the model (Lin, 1997). Similarly, the spectrum for a particular time interval can be calculated by averaging the filter parameters over that interval.

d) Cross-Spectra: By transferring the time domain results into the frequency domain, we could also show how the relationship between the wages growth in two economies has developed at different cycle lengths. That would allow us to investigate whether any convergence in degrees of wage had taken place over time and, if so, at which cycle lengths. As a measure of that relationship, we might use the coherence. However, we do not go to that far in this paper. Instead we restrict ourselves to examining the flexibility of wages, as revealed by the relative power of the associated spectrum at each frequency for each country in our sample; and whether that flexibility measure has been increasing or decreasing over time – in particular whether it has been increasing as the competitive pressures and need for market flexibility have come into play with the single market and single currency in Europe. That amounts to a search for changes in the underlying data generating process (i.e. in the AR(p) model) itself. That cannot be done with standard time-invariant econometric techniques.

e) Structural Breaks: Last, a note on the figures in this paper. We first present the time-varying spectra and then discuss the structural break tests. One can see from these figures that the spectra change. However, one cannot infer directly from those figures alone that the changes in the spectra are all statistically significant. The figures for the time-varying spectra have to be accompanied by the fluctuation test results. Once a significant structural break has been identified by the fluctuations test, the results of that will show up as significant break in the wages behaviour in the associated spectrum. We have picked out all the relevant break points in our summary Table 2 in the main text.