TWO CONCERNS FOR THE PHILLIPS CURVE

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In this paper we consider two concerns for the Phillips Curve. The first is asymmetry. Typically Phillips curves are assumed to be linear in recent modelling. We show using data from the euro area that important nonlinearities exist and that to some extent the 'flattening' of the Phillips curve in recent years reflects the greater success of monetary policy in keeping inflation down and behaviour on the less steep parts of the curve. We also explore the extent to which departures from the curve are asymmetric. We use an (M)TAR approach to show that the persistence of inflation varies according to whether shocks take inflation above or below the curve and according to whether this applies to the steeper or flatter segments. The second relates to the use of 'real time' information. We show that the New Keynesian model offers a better explanation of behaviour if real time data are used, particularly with regard to the measurement of expectations. We use both OECD forecasts and survey data to approximate expectations and find that this removes the tendency to get perverse estimates of the output or employment gap and suggests that people are more forward looking than is implied by the use of the rational expectations hypothesis.

1 Introduction

Our focus in this paper is with two issues relating to the Phillips curve that have implications for the formulation of monetary policy in the euro area. Our first concern is that the Phillips curve may be asymmetric and hence that the use of simple aggregate estimates, particularly using linear representations, might lead to suboptimal policy settings, in which interest rates are not adjusted sufficiently in either upturns or downturns. While it is noticeable that the Federal Reserve has been more active in policy setting than the Eurosystem in recent years, we do not imply that policy makers themselves have not taken sufficient account of this asymmetry. Our second concern is that ex post estimates of the Phillips Curve, using the most up to date revised data do not provide a good representation of the relationships that policy makers believed to hold at the time. We therefore re-estimate the Phillips curve using ‘real time’ data. However, our definition of real time goes rather further than many as we not only use the version of the data on the past that was actually available at the time decisions were taken but we also base expectations on the forecasts of the time rather than on subsequent estimates of what the actual values were. We thus treat the problem without the benefit of hindsight. In each case we use quarterly panel data from the OECD for the euro area countries over the last 30 years.

1.1 *Asymmetry*

The euro area has a single monetary policy for quite a diverse region. While it is widely appreciated that monetary policy is a ‘blunt instrument’ and that what is appropriate for the euro economy as a whole may have adverse effects both for individual sectors and for particular geographical parts of the area, some of the consequences of this for the setting of policy have been little discussed. Euro area policy simulations are usually conducted with models that either use euro level aggregated data or which handle the euro countries separately (with appropriate cross-country constraints) and aggregate the results. Such aggregations are usually either unweighted or based on GDP or similar weights. However, these straightforward approaches are based on the assumption that the behaviour we seek to model is largely linear over the relevant range. In this paper we show that there are strong grounds for believing that there are significant asymmetries and nonlinearities in inflationary behaviour. Ignoring these could have substantial adverse effects on particular sectors, regions and member states within the euro area.

These themes have been dealt with in a number of different ways in the past and our analysis runs across them. In particular we combine the idea of asymmetric business cycles (Freidman, 1993; Kim and Nelson, 1999) with the evidence that sectoral patterns matter as an explanation of how asymmetric the response is on each occasion (Lilien, 1982; Davis *et al*. 1996; Haltiwanger and Schuh, 1999). It has long been suggested that business cycles may be asymmetric in a number of respects. Keynes (1936), for example, suggests that downturns may be sharper than upturns and consequently that recoveries take longer than declines. This asymmetry may occur even within fairly homogeneous economies or single sectors. Most explanations focus on the labour market, however, we suggest that policy may also be asymmetric. Haltiwanger and Schuh (1999) show that the bulk of adjustment tends to occur within each industrial sector rather than across them. In a recession there is far more shaking out of employment from some firms and absorption by others than in recoveries. If getting new jobs is costly, not just through search but because an element of retraining may be necessary then this will of itself generate asymmetry. If the change requires considerable inter-sectoral movement then the costs and hence the asymmetry will tend to be greater. This will be exacerbated in economies like the euro area where labour mobility between regions, not merely between member states, is decidedly limited.

These problems are not new and apply to any diversified economy. They are particularly obvious in small open economies where monetary policy has a very different bite on the tradeable sector from the nontradeable. The adjustment for inflationary pressures will be concentrated on those sectors that are most flexible and may not correspond to those where the inflationary pressure is greatest. In such an economy raising interest rates through monetary policy to reduce future inflationary pressures will also raise the exchange rate. Tradeable sectors will be then affected directly both by the exchange rate effect and the interest rate effect, whereas nontradeable sectors will only be directly affected by the interest rate and indirectly by the consequence of the exchange rate on the tradeable sectors. However, it is not uncommon to find that inflationary pressures are at their greatest in the housing and construction sector, which is one of the least tradeable (Mayes and Viren, 2002). Because it is difficult to expand supply rapidly, both through planning restrictions and through the size of the construction sector prices rise rapidly. Since buildings last for many years their prices behave like other asset prices and rise much more rapidly than the general price level in response to any increase in growth expectations. Thus on the one hand policy may be relatively ineffective because its impact tends not to fall where the main problem lies. On the other the costs of policy may be higher in order to have the desired effect on inflation.

In a linear world all components in the price index are of ‘equal’ importance (i.e. as important as their weight in the index). Hence one can just as easily point to prices that are not falling ‘fast enough’ as causing overall inflation as to those that are rising fastest. But in a nonlinear world small changes in overall pressures lead to much more than proportionate increases in prices at the upper end of the distribution than to lesser declines at the lower. Similar asymmetric arguments are applied on the way down. Menu costs lead people to leave prices alone when the need for change is small but then to move them by at least the full amount of the relative costs change when the time for a move comes.

Thus the word ‘asymmetry’ is used with several meanings in the current context but all are variations on the theme that behaviour is different either side of a specific value of a variable. In the context of business cycles three forms of asymmetry are normally discussed: *deepness* – do recessions tend to be deeper than booms are high (compared to some trend or sustainable growth path); *length* – do recessions tend to shorter than expansions and *steepness* – does the decline occur more rapidly than the recovery. Mayes (1986) extends this discussion to a wider area of applications – for example it takes a long time to build up a reputation but a single bad mistake can destroy it. Rebuilding a lost reputation can be even slower than the initial building.

In the context of the Phillips curve much of the discussion of 'asymmetry' relates to the fact that the relationship is not a straight line. Hence the relationship is asymmetric in that unemployment below the NAIRU will tend to result in increasing and eventually explosive inflation while excess unemployment will have a diminishing effect tailing away into insignificance. However, it is asymmetric in a different sense in the discussion of the 'sacrifice ratio' (Mayes and Chapple, 1995). Here the gains in terms of extra output when the output gap is positive are more than offset by the losses when a negative output gap has to open to return inflation to its previous level. In this case the relationship is not merely a curve but its shape depends upon whether the output gap is falling or rising.

The problem can be regional rather than sectoral. This is illustrated for the UK by Buxton and Mayes (1986). They show that it was unemployment in the region with the tightest labour market (the Southeast) that had the main impact on inflationary pressure in the economy as a whole. Unemployment in other regions where pressures were slacker had far less impact. Disinflationary policy, particularly during the 1970s and early 1980s, not merely increased the level of unemployment in the country but it increased the spread. In order to have an adequate impact on the tightest labour market average unemployment had to increase more than proportionately and the unemployment in the worst affected regions even more dramatically. The regional variation may occur simply because of the uneven distribution of the various sectors of the economy.

The euro area is different from most other currency areas in that it has considerable variation in the transmission of monetary policy even within the same sectors because of different institutions and traditions for financing economic activity and saving. This will complicate the nature of the differences in the impact and lead to another source of regional variation. As we explain below some parts of the euro area could be persistently adversely affected if asymmetries are not taken into account.

1.2 *Real Time*

One of the problems in the analysis of economic relationships is that it is necessary to explain people's behaviour in the context of what they knew and believed at the time. This is particularly clear in the case of policy decisions, as has been illustrated by Orphanides (2001) for the United States and Huang *et al*. (2001) for New Zealand, inter alia. With the benefit of hindsight, it can be difficult to understand how some large policy errors could have been made. Once data available at the time (real time data) are used in regressions then explanation of the decisions improves. Using data that takes into account all the subsequent revisions and improvements may give a better representation of what was actually happening at the time but it is not necessarily as good an estimate of what people thought was the case at the time.

Decision-makers, of course, know that the information they face is imperfect and they take steps to go beyond the published statistics in building a view (Coats *et al.,* 2003). Hence, just as using the most recently revised data may not be an appropriate description of what people believed at the time, so also may the version of the data available at the time not be an accurate description of beliefs. Most relevant decisions are forward-looking, so the discussion extends beyond the simple concern over what was published. We, therefore, use estimates published at the time by forecasters as our real time data, rather than just the first estimates published by the statistical authorities after the event, as these take a wider set of information into account.[1]

[1] It is easy to regard the official statistics as being 'data' while referring to other people's views as being 'estimates'. Macroeconomic 'data', whether official or not, are still the result of estimation and not direct observation. Official estimates are subject to revision as more information comes to light, especially if series become implausibly uneven or inconsistent with estimates of other related variables. Outside estimates tend to make much more use of economic models than do those produced by the official statisticians, who place more weight on aggregating detailed estimates of components of the macroeconomic variable. Although we use a common OECD source, *Economic Outlook*, for

Addressing this problem is particularly important if we are trying to describe expectations, as these are not directly observable. Expectations are rooted in the information set available at the time. Hence it is worth exploring whether the most recent estimates or real time data act as a better explanation. Expectations and forecasts are closely related. Indeed if the forecast being discussed is the estimate of the mean value of the distribution of possible outcomes then the concepts are similar. If, like the estimates described in the previous paragraph, they are simply an attempt to predict the statistical authority's estimates, they should be quite a close conceptual match.

The key distinction is that forecasts can be observed. Hence they are potentially a proxy for expectations. They are also a real time source of information in that a stream of them is available for the main variables in the economy. Unfortunately, they have several drawbacks. Firstly, only some forecasts are published. Secondly, each forecasting group uses a different basis for its forecast – most are highly conditional, some implausibly so in using unchanged settings for monetary policy (Mayes and Tarkka, 2002). Thus not only does each forecast only represent what a particular group claims to think, these numbers are often not estimates of the expected value even though they are forward-looking. It is clear that some forecasters are considering the mode rather than the mean. The Bank of England, for example, explicitly considers the difference between the two in setting out the plausible distribution of outcomes (Novo and Pinheiro, 2003).

Published forecasts are thus not necessarily very representative of what people were thinking at the time and may not be a very good estimator of expectations, even if we combine forecasts from a number of sources. Such combinations can be the published Consensus Forecasts or statistical combinations of the information along the lines of Stock and Watson (1999). It is clearly debatable how they perform relative to other estimators, all of which have their drawbacks. It is, for example, possible to use surveys of opinion in some cases. Their validity depends on how representative the sample is and how well people are able to describe their position on the particular topic.[2] However, if we are merely concerned with trying to explain how a central bank reacts, given its own views about the future, then we can use its forecasts to represent expectations.[3]

In this paper we seek to use both sorts of 'real time data' that we have discussed – the estimates available at the time and published forecasts. We extend this realism as far as possible by using the most recent vintage of the historical series of the variables that was available at the time as well. We pick all of these, historical data, estimates of the current period and forecasts from the same source.

However, the process of estimation of the Phillips curve throws up a further difficulty, as we should normally consider the use of GMM or some other method of handling measurement errors and simultaneous determination of the explanatory variables in the relationship. To achieve the necessary identification we should use a set of variables that give a good explanation of the explanatory variables but are not themselves correlated with the error term in the equation.[4] Such variables should be 'predetermined' but does this mean that they should have been 'known at the time' i.e. real time data? One of the problems here is consistency. If we are using real time data for the explanation in the model then should the instruments themselves also be of precisely the same

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building up our information on what was believed at the time about the past, current and future values of output and inflation, the methods used by the OECD for producing these three categories of estimates are different. Estimates of the past are largely harmonised combinations from official statistical agencies, whereas estimates of the current and future periods employ the normal range of forecasting techniques, which vary depending on the time horizon from the latest period for which the most recent official estimates are available.

[2]It seems impossible to find forecasts made for all euro area countries for a substantial period other than from OECD (Gerlach, 2004). Consensus Economics now produce suitable forecasts for much of the euro area but prior to 1995, inflation data relate only to France, Germany and Italy, which is insufficient. The results in Gerlach (2004) suggest aggregated Consensus Economics estimates for the euro area perform noticeably worse than our estimates from OECD.

[3] This is not without problems if we wish to have a more complete model as then we may have multiple expectations: expectations held by the central bank and expectations held by the rest of the economy (Honkapohja and Mitra, 2005).

[4] One way of looking at this (Rudd and Whelan, 2001) is that they should not simply be 'omitted variables' from the proper explanation.

vintage of publication/knowledge? This introduces a further quirk in estimation. It is common to use lagged variables as instruments but the real time lagged variable is not the lag of the real time variable. In other words it is each period's 'published' estimate of the previous period(s) that is appropriate. The estimate made last period of the then current value will have been revised, along with estimates of earlier periods. The empirical importance will depend on both the extent of revision of the data series and on the model being estimated. Thus the compilation of the instrument data set will require using all of the vintages of data in the same way that is required for the real time data itself.

In the sections which follow we look at each of the issues in turn: the use of real time information in the form of forecasts to act as an estimator of expectations, the use of real time data in the sense of the information available at the time and the use of real time instruments. We begin by outlining our approach to the Phillips curve and the datasets relating to the euro area countries that we employ.

2. The Phillips Curve

We deliberately use the well-known hybrid New Keynesian specification of the Phillips curve as a representation of the prevailing view and one which allows us to explore both our concerns readily. It also makes the results directly comparable with a wide range of evidence already available. It is particularly relevant to our real time concerns, as not only do expectations lie at the heart of the explanation but many versions of the specification use an output gap as an explanatory variable, which is also an unobservable variable that needs to be estimated. Many measures of output gaps suffer from the 'end point' problem, which makes the role of real time data even more important, as it tends to be the most recent observations that are changed the most. It is only well after the event that we can form a clear view of whether the trend from which the gap is measured has itself changed. In the short-run there is considerable scope for confusing gaps with changes in trend.

The original NK specification is:

$$\pi_t = \lambda \sum_{k=0}^{\infty} \beta^k \mathrm{E}_t \{ mc_{t+k} \}, \tag{1}$$

where E_t is the expectations operator conditional on information available in period t, π_t denotes the period t inflation rate, defined as the rate of change of prices from period t–1 to period t, suggesting inflation is equal to the discounted stream of future real marginal costs, *mc*. As it is usually impossible to obtain a direct estimate of these costs, empirical studies commonly use the output gap as a proxy, although labour costs are also used (Galí and Gertler, 1999; Sbordone, 2002). These variables are assumed to capture changes in real marginal costs associated with variation in excess demand in the economy. Under certain assumptions about technology, preferences and the structure of labour markets we can link the output to real marginal costs within a local neighbourhood of the steady state of log real marginal costs according to $mc_t = \delta \hat{y}_t$ (Fuhrer and Moore, 1995; Roberts, 1998) where $\hat{y}_t$ denotes the period t excess demand and hence by substitution obtain:

$$\pi_t = \beta \mathrm{E}_t \{ \pi_{t+1} \} + \kappa \hat{y}_t, \tag{2}$$

for the NK relationship, where $\kappa = \lambda\delta$.

Many empirical studies suggest that the purely forward-looking NK Phillips curve is unable to capture the persistence of inflation and hence it has typically been modified by incorporating some backward-looking element. The Hybrid model of Galí and Gertler (1999) is the main example:

$$\pi_t = \theta \mathrm{E}_t \{ \pi_{t+1} \} + (1-\theta)\pi_{t-1} + \phi \hat{y}_t, \tag{3}$$

where $0 \leq q \leq 1$.[5] We use this Hybrid model as our starting point.

Expressing inflation in terms of prices and not wages and demand pressure in terms of output gaps and related measures and not unemployment makes sweeping modifications to the original Phillips (1958) specification. However, our purpose is not to innovate with specifications but to explore the impact of real time information on specifications that are already widely used. It is by no means certain that the results would generalise to other specifications.

2 The First Concern: Asymmetry in the Phillips Curve

2.1 *The Nature of Asymmetry*

Before we go any further we need to sort out what is meant by asymmetry, as there is no commonly accepted definition.[6] Sorting out nonlinearity is a simpler task as we take it here to refer to relationships that are curvilinear or have different parameter values over different ranges, rather than exhibiting discontinuities or chaotic behaviour.

In the European context the most common use of the word ‘asymmetric’ merely means ‘different’. The simplest example comes in the concept of asymmetric shocks, which are just shocks that affect one part of the economy rather than another. Secondly, asymmetry is commonly used to refer to relationships where there are omitted variables or even omitted secondary equations. Gaiotti and Generale (2001) and Loupias *et al.* (2001) in showing that there is a credit channel for monetary policy describe this additional feature as ‘asymmetry’ in the monetary transmission mechanism.

Here we begin by defining asymmetry much more directly - that relationships are not symmetric in the sense of having the same coefficients either side of given value. Thus a relationship

$$x = a_0 + a_1 y + e \tag{4}$$

is not symmetric if a_1 ¹ a_2 in

$$x = a_0 + a_1 y^+ + a_2 y^- + e \tag{5}$$

where $y^- = y$ when $y < y^T$ (= 0 elsewhere) and $y^+ = y$ when $y \geq y^T$ (= 0 elsewhere). y^T is a ‘threshold’ value (Granger and Teräsvirta, 1993; Tong, 1993). A simple example for the Phillips curve, is to suggest that inflation responds differently depending upon whether the output gap is positive or negative. We can easily respecify x and y in first difference form (or first difference of logarithms) and show that for example the impact of changes in GDP on unemployment depend on whether the economy is growing or contracting.[7]

We have deliberately made this asymmetry very simple but one could argue that while the cointegrating relationship is symmetric the error correction mechanism could be asymmetric (Harris and Silverstone (1999) and Huang *et al.* (2001)). Thus, if $\hat{a}_0$ and $\hat{a}_1$ are the estimated values of a_0

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[5] In Paloviita and Mayes (2006) we have also explored using further lags of prices (Galí et al., 2001; Jondeau and Le Bihan, 2003) and the labour share of income rather than the output gap.

[6] Much of the traditional treatment of asymmetry (Keynes, 1936; Diebold and Rudebusch, 1999) is concerned with the shape of the business cycle. Three characteristics of asymmetry in shape can be identified: *deepness* – do recessions tend to be deeper than booms are high (compared to some trend or sustainable growth path); *length* – do expansions tend to last longer than recessions and *steepness* – does the decline occur more rapidly than the recovery.

[7] Corrado and Holly (2003) try to estimate a general hyperbolic functional form for the Phillips curve. In practice, they end up by estimating two thresholds. Their results for the UK and the US suggest that the Phillips curve is steeper for larger positive output gaps than it is for larger negative gaps, while in the middle, for small positive and negative gaps, the curve is fairly flat.

and a_1 and $\hat{e} = x - \hat{a}_0 - \hat{a}_1 y$ the computed error, then the error correction process will be asymmetric if $c_2 \neq c_3$ in

$$\Delta x = c_0 + c_1 \, \mathrm{D}y + c_2 \, \hat{e}^{+}_{-1} + c_3 \hat{e}^{-}_{-1} + \eta \qquad (6)$$

where $\hat{e}^{-} = \hat{e}$ when $\hat{e} < \hat{e}^{T}$ and $\hat{e}^{+} = \hat{e}$ when $\hat{e} \geq \hat{e}^{T}$ (= 0 elsewhere), $\hat{e}^{T}$ being the 'threshold' value. It is possible to specify the asymmetric adjustment process in terms of $\Delta\hat{e}$, as in Huang *et al.* (2001), using the M-TAR model of Enders and Siklos (2001), rather than the TAR model in terms of $\hat{e}$, described in (6). M stands for momentum and we go on to explore that approach second.[8]

We thus begin by applying the form of asymmetry in (5) to the hybrid Phillips curve shown in (3)

$$\mathrm{p}_t = a_0 + a_1 \mathrm{p}_{t-1} + a_2 \mathrm{p}^{e} + a_3 \nabla y^{+} + a_4 \nabla y^{-} + u \qquad (7)$$

where ∇y^{+} denotes the values of the output gap that exceed the threshold value and accordingly ∇y^{-} denotes the remaining values of ∇y, p^{e} is expected inflation for ease of notation. By having these two facets unlike much of the rest of the literature we take at least one step towards admitting that the Phillips curve is a curve.[9]

All reported estimates have been derived using a panel data and restricting the key parameters to be the same for all countries and periods (although, with some exceptions). All equations have been estimated with Least Squares (LS) and Generalized Least Squares (GLS). Because all equations include lagged dependent variables (either directly or in the error-correction terms) we have also used the Arellano-Bond version of the Generalized Method of Moments Estimators (GMM). To illustrate the robustness of results, we present results from all estimators although space prevents a complete report.

2.2 *Asymmetry in the Phillips Curve*

There is no shortage of estimates of Phillips curves in recent years. Estimating the conventional New Keynesian hybrid equation gives the result that forward and backward looking inflation expectations are equally important and that a perverse sign is achieved for the output gap. In part this stems from trying to estimate the curve as if it were a straight line. As soon as even a two part linear specification is permitted the sign is corrected and the slopes for positive and negative output gaps are clearly different. In particular, when the output gap is negative and the economy is characterized by slack capacity the Phillips curve is nearly horizontal. This flattening confirms the flattening that has been observed more generally as inflation rates fall. However, it is important to see that this feature does not apply to positive output gaps. In the case of the Phillips curve differences between the euro area and the rest of the EU do matter. Elsewhere inflation is not so responsive, in part perhaps because the economies are more open to the world outside the euro area.

The nature of results changes considerably if we consider forward-looking expectations and estimate the New Keynesian hybrid Phillips curve using the Generalized Method of Moments in a

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[8] Furthermore, one could assume that the distributions of errors or shocks are not symmetric, as is the case in frontier models (Mayes *et al.* 1994). All of the above would constitute examples of asymmetry in the more restricted sense that we use it.

[9] Obviously we could have more than two regimes (facets) for ∇y but since we have only limited numbers of observations we use this simple specification (which has been widely used elsewhere, see Yates (1998) for instance). Alternatively we could smooth the once-and-for-all regime shift in the threshold model by using the so-called smooth transition regression model (STR) (Granger and Teräsvirta, 1993), also used by Teräsvirta and Eliasson (1998). The lack of sufficiently long time series also made this alternative less appealing. Introducing a quadratic term in the output gap would also be a straightforward way of incorporating nonlinearity.

dynamic panel framework (Arellano and Bond, 1991). The results (Table 1) clearly indicate that the role of the lagged inflation term (inflation persistence) diminishes over time and is relatively unimportant for the 1999-2006 period. By contrast the role of output gap becomes more prominent. Contrary to the 1987-1998 period, the coefficient is clearly significant. Thus, for the EMU period, the New Keynesian hybrid Phillips curve work reasonably well; it is only that the sum of the inflation coefficients fall short of one, which suggests that there are some problems in the modelling inflation expectations with the REH assumption under the GMM orthogonality restrictions.

However, in earlier work (Paloviita, and Mayes, 2005; Paloviita and Virén, 2005) we have found that the rational expectations formation is a rather strong assumption and that if instead we use OECD forecasts or Consensus Economics survey data, we get a better determined equation and a much larger forward-looking weight, more in line with what is expected from the New Keynesian model.[10] This is again true here (Table 2). The model becomes around 60% forward-looking throughout and the output gap becomes significant and correctly signed once we restrict estimation to the monetary union era. However, simply assuming that that monetary union can best be represented by the period from 1999 onwards does not seem the best explanation. Taking the starting date backwards in time progressively (Table 3) suggests that the change in behaviour occurs around 1996. This break-point is more or less the same for the two data sets used in estimating the New Keynesian Phillips curve. Thus it is when the member states were trying to converge under Stage 2 of EMU that their behaviour changed and this change has continued thereafter.

Prior 1995 or so, the New Keynesian Philips curves perform rather badly in the sense that, according to the coefficient estimates, inflation seemed to be more or less unrelated to output gap (or other cyclical variables). Along with the EMU, the theory-consistent role of output gap experienced a new comeback (Tables 1 and 2). This is not so much because of the output gap variable itself but because of the new role of inflation expectations. Before the EMU there was no genuine monetary-policy-anchored European view of future inflation developments. Nevertheless, there could some more technical reasons for the observed pattern of results. After the early 1990s both inflation and inflation expectations have been stationary which makes estimation of Philips curves much easier, although there are no guarantees that the estimates do not represent some spurious correlations. For the data of the 1970s and 1980s inflation and inflation expectations seemed to have some trend while the output gap variable is 'by construction' a stationary variable (Baxter, 1994).

One interesting feature is that the year 1999 creates some problems to the all expectations oriented Phillips curves (Figure 1). Thus, in the New Keynesian Phillips curve, the expectations channel appears to be temporary out of use for 1999 but start being operative since that. Price developments in 1999 were largely independent of the future inflation expectation. This could be interpreted in two ways: either there has been a lot of noise in inflation in 1999 (due to adoption of the euro) or there has been a lot uncertainty in terms of future monetary policy and inflation regime. Perhaps this is all a coincidence but that would be surprising.

[section on M-TAR estimates to come]

3 The Second Concern: The Use of Real Time Data

3.1 *Forms of Real Time Information*

The first of the three sources of real time information that we explore relates directly to expectations. A common approach is to assume rational expectations and try to model expectations directly from the model. Rational expectations are normally expressed, however, in terms of the

[10] We use both the June and December forecasts for the following year but the results are fairly similar in character.

most up to date information. A construct based on the information available at the time could be made 'model consistent' but strictly rational expectations would imply that they were 'correct' not just that they conformed to a specific less-revised dataset. In any case, not only does the rational expectations assumption impose substantial problems for estimation (Rudd and Whelan, 2001) but it perpetuates the problem of handling an unobservable (two actually, since the output gap is also unobservable). We therefore consider a less ambitious assumption and employ a direct measure of expectations as a means of getting at what people thought at the time from the information available to them. We use published OECD forecasts (Pyyhtiä, 1999). These forecasts were generally available at the time pricing decisions were taken. While there is no particular reason to suppose that the OECD represented general beliefs, such forecasts were widely discussed and respected. More importantly from the point of view of our analysis, they are produced by a coherent methodology that is applied to each of the euro area countries and evolves only slowly across time. There is nothing similar available with such a coverage. Even so with only annual data stretching over the period 1977-2003, this is a very limited sample to operate on. We have therefore chosen to pool the data and estimate the model in panel form, which gives us a maximum around 300 observations, depending on the exact specification.[11]

By using direct measures of inflation expectations, we can avoid the problem faced by many previous studies of inflation dynamics, of having to test dual hypotheses, about the specification of the Phillips curve and the formation of expectations, at the same time.[12] Thus, in our study we can allow for the possibility that the expectations themselves may adjust slowly or move for spurious reasons. A simple form of explanation would be to use one of the specifications of least squares or other learning processes (Evans and Honkapohja, 2002). The OECD forecasts are likely to be more reliable proxies for inflation expectations than some survey estimates that have been used, as they are based on systematic monitoring of economic developments and econometric models.

The OECD's forecasts are produced twice a year and published in June and December. The June forecasts are normally for the current and the next calendar year, while a second future year has been added in December, in recent years. They cover, inter alia, inflation in both the GDP and consumer price deflators. OECD's database is quarterly, so it would be possible to compile semi-annual series for all the variables and estimate the models on that frequency. One can also interpolate the series of forecasts and hence estimate the models at quarterly frequency.[13] However, we stick with the annual information. The timing of the forecasts raises the first question about what real time constitutes. Pricing decisions that affect both deflators will be taking place during much of every working day and probably outside them as well. The annual outcome is the result of a mass of decisions spread, unevenly over the year. There are some important elements of bunching in the early part of the year, both with administered prices and wage-setting in many euro area countries over the period. This might argue that the December forecasts were more typical of the information available. On the other hand the June forecast coincides with the publication of the first estimates of the outcome for the previous year, so perhaps this has more merit. We explore both but focus on the December forecasts because they look slightly further ahead than those in June.[14]

[11] Not all series are of equal length and the availability for particular countries varies slightly. It is, however, the forecast information that starts in 1977 for ten countries in the euro area. For Luxembourg, the forecasts are available since 1982 and for Portugal since 1980. We can and do go back earlier to 1960 with the historical series published by the OECD since 1977, particular in the case of real GDP, when estimating output gaps.

[12] Roberts (1997, 1998) and Adam and Padula (2003) provide similar studies with survey based expectations for the US.

[13] Normally interpolation is done with some reluctance because of the effect it has on the dynamics of the relationship. In this case it might actually be desirable because the OECD forecasts are only a proxy and some smoothing of their impact might be appropriate. We only take them as representative of a more general view, not that their publication constitutes 'news' on which behaviour would change.

[14] These differences in horizon and information base pose problems for a semi-annual approach. Not only will the timeliness of the published information available alternate between the June and December OECD estimates but the length of the forecast horizon will also vary by six months.

One advantage of using OECD forecasts is that the self-same publication the OECD *Economic Outlook,* produces compatible data series for the history of the variables in the model and estimates of their current value.[15] Since we are dealing with estimates made in December for the current year, they still contain an element of forecasting. This emphasises a general problem in estimation in that reliable official estimates may only be available with a considerable lag. The first published vintage of the data for a particular year are not really 'real time', as they appear after the decisions have taken.[16] We explore using the OECD's own 'real time' estimates of the output gap published in *Economic Outlook* as well, so that the entire model is expressed only in terms of the information actually used at the time price setting decisions are made. But they are only available for a few years, so it is also necessary to estimate the gap using relatively robust methods to represent what could been done over the period with the real time data and the techniques then available.

The second element of real time information we consider relates to the data set used in constructing the output gap. If we use up to date information we actually know with the benefit of hindsight what happened to output in subsequent periods and hence can avoid the well known end point problem. However, at the time people cannot avoid the problem. They have to make judgements about how appropriate trend values should be estimated and as Orphanides (2001) has shown this can help explain some large policy errors. HP filters are particular subject to this difficulty and it would be very helpful if we could use a different form of estimation, say, the production function approach that the OECD uses. It is arguable (Neiss and Nelson, 2002; Robinson *et al.*, 2003; Orphanides and van Norden, 2002) that estimating the output gap will dominate the problems that people faced at the time from having to use real time data. However, using more sophisticated methods would not replicate what people might reasonably have done at the time.[17] It is particularly unfortunate therefore that these potentially less contaminated estimates of the output gap by the OECD only stretch as far back as 1994. We are therefore compelled to use the HP filter or similar rather deficient methods if we want to consider the whole data period. Although we can use the full extent of the OECD output forecasts available in calculating the filter, we need to use real time data in estimating the output gaps as they would have been seen at the time.[18]

Lastly in estimation, we apply real time data in the GMM estimation process. Here the question of what data set should be used is more contentious. GMM is a statistical technique. Appropriate instruments need to be predetermined and correlated with the variables they seek to explain but uncorrelated with the error term. Using GMM does not per se involve the question of what information was available at the time. It might however, seem more logical to use a common data set so that the instruments are also what was available at the time. By using more up to date information in one part of the estimation process than in another we may introduce spurious correlations. The issue of simultaneity would be represented by using the same real time data set even if it might be statistically easier to handle it with different information. In this sort of context

[15] Prior to 1985 (1983 for France, Germany and Italy) *Economic Outlook* did not contain estimates of inflation two periods earlier. These real time estimates are needed for the instrument set. We therefore used the nearest estimate in time published in the OECD *National Accounts*. The decision over which year's estimates to use was based on the degree of correlation between the *National Accounts* and the *Economic Outlook* estimates in the years from 1985 onwards where we had both sets of estimates. This was done country by country, as the lag in information provided to the OECD by national statistical authorities varies. For five countries the current year *National Accounts* were used and the next year's for the remainder. While this muddies the definition of real time, the effect is likely to be small.

[16] This would not be such a problem with a backward-looking specification or higher frequency model, if data are published quickly. As it is, the current year 'estimate' will be based on initial published data for the first part of the year, estimates of related and indicator variables for the middle part of the year and forecasts combining backward and forward-looking information for the last few months of the year.

[17] Using 'one-sided' filters may reduce the problem.

[18] There is clearly a trade off here between considering robust methods of estimation using real time data that might have been more in line with contemporary estimates and using more reliable estimates. The difference between the two may help to explain policy errors.

one of the functions of GMM is to help clear up an 'errors in variables' problem. If we assume that the final estimates are more accurate then inevitably the real time estimates must include an error. We conduct some limited tests for bias to see if we can get a prima facie indication.

We thus have quite a complex database that contains a series for each variable in the model every year. Since we have used 26 issues of the OECD *Economic Outlook* annually from 1977 to 2002 we have 26 sets of series on each variable.[19] Thus the real time data for a variable x in period t consist of series running from the first year recorded, 1960 in most cases, through to $t + 2$, i.e $_t x_{1960+\tau}$, $\tau = 0, \ldots, t + 2$; $t = 1977, \ldots, 2002$. The observations from 1960 to $t - 1$ will be published 'data', t will be an 'estimate'[20] and $t + 1$ and $t + 2$, are forecasts, all published by the OECD in December of year t. These then have to be placed into the appropriate series for estimation. Real time forecasts made in year t for year $t + 1$ are thus denoted $_t x_{t+1}$, real time lagged values are $_t x_{t-l}$, where l is the lag, and forecasts made last year for this year are $_{t-1} x_t$. Thus there is always a contrast between real time and the most recently published estimates. However, for the last data point, 2002, the most recent data have not as yet been revised. Since many of the main revisions occur early in the first year or two, we could end the real time data earlier by eliminating the most recent observations if we wished to increase the potential difference between the last real time observation and the most recently published revised estimate. How many years we should omit in this way is fairly arbitrary unless we could reach a point where the data are not further revised. Since that involves knowledge of what the statisticians at the OECD might do in future revisions, which they themselves do not know, there can be no 'right' answer. The more periods we omit the poorer our explanation of the Phillips curve is likely to be. There is thus a trade off. We can gain some insight over the appropriate choice from the pattern of previous data revision by the OECD.

There are typically two sorts of revisions to the OECD data.[21] In the first few periods there may be fairly substantial revisions and then at less frequent intervals there are comprehensive revisions to the series over quite a long time period, usually coinciding with rebasing, particularly for constant prices. This second type of revision tends to shift the series as a whole rather than simply individual observations. This difference is important in context of the Phillips curve, as variables are expressed either in rates of change or compared to some form of 'trend'. Shifting a series may have little effect on rates of change but it can alter the complexion of deviations from trend, particularly where there are nonlinearities or asymmetries. It is noticeable that the revisions have typically been greatest round the turning points. Since turning points are also associated with forecast errors, this has the potential for even larger real time discrepancies. It is also observable that there can be noticeable changes even 10 years or more after the event. The second issue can matter much more for the output gap, as it is a derived measure and not just a published series. The case of Spain shown in Figure 2 is particularly striking. While the shape of the output gap does not change a lot, where it is pitched can. The revision between 1999 and 2000 is particularly large but its greatest effect is not on the immediate period but on the estimates of the fairly recent past. The profile of the data has been shifted rather than individual observations. To some extent this represents an upward revision of the underlying rate of growth.

It is fairly obvious that the inflation series are not subject to substantial revision, Table 4.[22] The real time series typically show correlation coefficients of 0.95 or better with both the revised estimates and with the forecasts.[23] In the case of the output gap however, we are looking at markedly different series, with correlation coefficients between 0.58 and 0.77 for the real time and

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[19] We have a 27[th] set of series from the December 2003 *Economic Outlook*, which is the source for our most recent revised data. The last complete year is thus 2002 as 2003 was not yet over in December. Hence the 2003 real time estimates cannot be used as they have no 'actual' value against which they can be compared.

[20] They are all of course estimates in the sense that we never know the true values.

[21] See Paloviita and Mayes (2006) for details on the impact of revisions for each of the four largest euro area economies.

[22] We explore both the GDP deflator and the private consumption deflator.

[23] The hypothesis of no correlation is rejected at least at the 5% level in all cases except that between the revised OECD and real time HP filtered estimates of the output gap in part 4(b) where the probability is slightly above 5%.

revised series. Not surprisingly the two estimation methods are somewhat more closely correlated for the same data, 0.86 to 0.88, but still less than the correlations between real time and revised price series.

We have also checked to see whether the discrepancies appear to be biased (Table 4c). Simple Wald tests comparing the real time and revised estimates suggest there are consistent differences between the two series in most cases. The clear exception is the real time GDP deflator. The nature of the discrepancy varies from case to case. The real time HP filter estimate of the output gap is on average about half of one percentage point below the estimates from the most recent data. We had anticipated that the end point problem would bias its absolute value towards zero, not this asymmetric bias. Real time consumer price inflation tends to underestimate the revised series. The OECD's output gap estimates, using the production function approach, have an average value nearly 0.4 of a percentage point lower and are poorly correlated.[24]

There is one correlated item in the revisions. Since real GDP is deflated nominal GDP and the GDP deflator is one of the inflation measures we use in the study, revisions to real GDP could come from one or both of two sources. Nominal GDP and/or the GDP deflator may have been revised. Thus there will tend to be some inverse correlation between revisions of real GDP and the GDP deflator. The change to the output gap, which is derived from the GDP series will be at one remove. Since the output gap for a single year is not dependent on GDP in just one year, it is not possible to go on to argue that revisions in the output gap and in the GDP deflator are therefore also likely to be correlated but it remains a possibility. In so far as such correlations do exist they can affect the extent of the change in the estimates from using real time data.

We face the normal problems in constructing the output gap and use an HP filter, not because it is obviously best but because it was the most widely used approach and does not involve further data series.[25] We follow the common procedure of using forecast values of real GDP to construct the filter in order to reduce the impact of the end-point problem. This only has to be done once with the revised data set. However, if we want real time output gaps we have to construct them from each data set in turn. Thus in period t, computing the output gap entails using the December year t OECD *Economic Outlook* to provide the most up to date estimates of real GDP in previous years, the estimate of year t and the forecasts of year $t + 1$, and $t + 2$ where it is available. All these estimates of the year t output gap, one from each December's *Economic Outlook*, have to be transcribed into the single output gap series for estimation. When using the OECD's own published estimates of the output gap, which use a production function and not an HP filter, they are treated just the same way as the most recent and real time series for the inflation variable.[26]

The evolution of each individual computation of the real time output gaps is illustrated in Figure 3 for Italy, as this shows the largest revisions of the four main euro area countries. [27] The first real time gap is thus computed for 1977, the beginning of our forecast sample, using the December 1977 vintage data including its forecasts. This line has its end point in 1978. There is then a new line superimposed for each succeeding year, all of them stretching back to 1960, which is our origin year for the data. The most heavily revised observations are the forecasts for the two years ahead, which are not used in estimating the Phillips curve itself but give the full flavour of how sensitive

[24] We have checked the data for stationarity, as its absence would affect the validity of the inferences. The downward trend in inflation in the first part of the period for many of the countries poses an obvious problem.

[25] As Rünstler (2002) has shown for the euro area, Orphanides and van Norden (2002) for the US and Cayen and Van Norden (2002) for Canada, Nelson and Nikolov (2001) for the UK and Gruen *et al* (2002) for Australia, measures of the output gap can vary widely according to the method used. Furthermore, as the output gap is a generated regressor it could present problems for inference (Pagan, 1984) despite the use of GMM.

[26] The OECD has only published its own estimates of the output gap since 1994, hence the need to present the correlations of these with other measures separately in Table 4b.

[27] Clearly in forming a judgement it was necessary to explore the patterns for all countries in the sample and not just for the four largest, although their experience will dominate the aggregate result.

output gaps are to the end point problem.[28] The extent of the revision in the output gaps used is clearer if all of the other observations are removed from the chart and only the sequence of real time gaps, without the history are shown, as in Figure 4, by comparison with the HP filtered gaps estimated using the most recent, December 2003, data. The deflators tend to show quite negligible differences by comparison, as can be anticipated from the high correlations in Table 4.

2.2. *The Use of Real Time Data in Estimation*

Our main results focus on the Hybrid model as this gives a more comprehensive opportunity to consider how forward-looking expectation formation appears to be. We constrain the coefficients on the backward and forward-looking expectation terms to sum to unity. The restriction is not confirmed by the data but the impact is quite small.[29] We used two inflation measures in estimation: the annual changes of the GDP deflator and the private consumption deflator, because both measures are widely used in the existing literature. Although the two series are strongly correlated, they show noticeable differences in estimation. Despite the rather wide range of results shown for individual countries in Paloviita and Mayes (2005) the restrictions entailed in pooling the data are not rejected for the GDP deflator.[30] In the case of the private consumption deflator the pooling restrictions are not rejected for ten countries, including the six largest. Only Austria and Finland fail to meet the criterion and they represent only 5 per cent of euro area GDP between them. The impact of omitting these two countries from the estimation is small so only the results using the full data set are shown.

It is immediately obvious from Table 5, using the maximum data set available, that the balance of expectations formation falls slightly in the forward-looking direction.[31] The successive rows, 1 - 4 and 5 - 8, show the effect of adding more real time information, for each of the GDP deflator (GDP) and consumers' expenditure deflator (CP) measures of inflation. Rows 1 and 5, which provide the starting point, with just the OECD forecasts included as the measure of expectations can be contrasted with rows 9 and 11 which show the effect of estimating the model using the actual outcome the following year, on the basis of the most recently revised data (December 2003 *Economic Outlook*).[32] The difference is surprisingly small despite the relatively low accuracy of the forecasts recorded in Table 4. Adding the real time estimate of lagged inflation makes relatively little difference but using our constructed real time estimate of the output gap with an HP filter leads to the well-known problem discussed above of obtaining a wrong-signed coefficient (Galí and Gertler, 1999). Given the rather poor determination of the output gap coefficients in any case, this should perhaps be no surprise. Expressing current inflation in real time terms, which is also an OECD forecast in that it is the estimate of the current year published in December but in effect

[28] The problem might be reduced by using a one-sided filter but, as the real time gaps produced by the OECD using the production function method show, real time and revised gaps vary considerably, whatever the method used in real time.

[29] The sum of the unrestricted coefficients when real time data are used throughout is slightly greater than unity (1.05 and 1.07 for the GDP and CP deflators) and the result is an increase in the relative importance of the forward-looking component. The output gap coefficients become positive but insignificantly so.

[30] In pooling we are treating all countries as if they were equally important. However, for some purposes it would be more relevant to weight the countries by their economic size so we have also used weighted regression to approximate what might apply across the euro area and in Paloviita and Mayes (2005) we estimated Phillips curves at the euro area level of aggregation. In this case much of the euro area information is synthetic. Not only did stage 3 of EMU not start until 1999 with the common currency only in the last year of our sample but in the early years it was not even in prospect. Five of the subsequent members were not even in the EU in that period. Using mean GDP weights on the real time data has the effect of reducing the forward-looking weight by around 10 per cent and removing (substantially reducing) the negative output gap coefficient for the GDP (CP) deflator equation.

[31] In Table 5 we have used OECD inflation forecasts since 1977 with the exception of Luxembourg and Portugal, where forecasts are only available from 1982 and 1980, respectively. This gives a total of 304 observations and not the 312 that would stem from a full balanced panel.

[32] Rows 10 and 12 show estimates using a second lag on inflation and a lag on the output gap as instruments.

based on only two quarters official estimates, increases the forward-looking weight considerably. In the consumers' expenditure case the forward-looking weight is now twice the backward-looking weight. As each item of real time information is added to the picture so the forward-looking component increases in importance. To some extent price setters appear to be able to take account of information that was not in the currently published data but was incorporated in the revised information after the event.

As we noted, it is unfortunate that we have to estimate a rather crude real-time measure of the output gap. Constructing some more elaborate multivariate estimate using real time data would increase the scale of the exercise substantially. While the OECD itself has computed estimates of the output gap using the production function method, these are only available in real time, i.e. published in *Economic Outlook*, since 1994. The result is a heavily truncated sample of only 99 observations (Table 6a).They have calculated output gaps using that method back to the beginning of our sample period but that uses revised data.

In this case the weights are slightly different with the forward-looking element in the consumers' expenditure deflator case being only a little above half while the GDP deflator sample gives a weight of two-thirds and above. Both are notably higher than what is observed if we use the most recent revised data. This is, of course, not a matched comparison as the sample in Table 5 is much longer. However, if we use the shorter sample with the HP-filtered estimates (Table 6b), the forward-looking weight is very similar to those when the OECD output gap estimates are used. The output gap coefficients are also positive. There is therefore some difference in behaviour in the two data periods. Inflation has been clearly lower since 1994 and hence in some senses easier to predict. However, it has also become more persistent, so it is not immediately obvious what the effect of this would be on the resultant estimates. Nevertheless it remains that real time data are able if anything to explain inflation a little better and have a noticeably larger forward-looking element in the explanation, in no case lower than the backward-looking weight.

3.3. *Real Time Instruments*

In this section we move on to consider the use of real time data for the instruments in GMM estimation. This aspect can be examined using a database that contains real time variables, not just for current values but also lagged information that was available at the time. When real time information is used in the expectations variable, it is logical to choose a common data set so that the instruments are also what were available at the time instead of final variables. As Orphanides (2001) points out, decision makers have to use noisy data without knowing what the noise is. If we use instruments without the noise then they may be correlated with the errors. They will also not be so well correlated with the omitted relationship, such as the setting of monetary policy.

In the Hybrid model, Table 7, using two lags of the output gap and the second lag on inflation as instruments, the immediate effect is to reduce the forward-looking weight considerably and steepen the slope of the Phillips curve.[33] In commenting on an earlier version of the paper, Orphanides argued that this is exactly what one would expect if monetary policy is also forward-looking and is captured by expectations. Since there is some doubt whether the normalisation used is the most suitable (Søndergaard, 2003) this may help explain the higher backward-looking weight, although Jondeau and Le Bihan (2003) argue that the bias in using GMM may be in the opposite direction. In any case there will be a degree of persistence observed in the data even if the decision-making process itself is entirely forward-looking (Goodfriend and King, 2001). Hence, it is important not to misinterpret the implications of empirical lags as suggesting that a less forward-looking monetary policy should be employed.

[33] This is a considerably smaller instrument set than used in Søndergaard (2003) or Galí and Gertler (1999) both in terms of range of variables and number of lags.

Overall, what is clear is that using real time instruments does have an effect. It would be inappropriate to ignore the appropriate choice of real time as opposed to most recent data for instruments as it has a material effect on the estimates.

4. Concluding remarks

A number of conclusions can be drawn on the basis this analysis. First of all, using real time information on expectations, in the form of forecasts – in this case those published by the OECD – does seem to act as an improvement over some simple adaptive or rational expectations approaches in estimating Phillips curves for the euro area countries in the period since the mid-1970s.

Second, using real time data in the model offers a marginal improvement to the explanation, although the principal means of estimating the output gap used, namely, an HP filter creates difficulties of its own, not least through the end point problem. If we tackle the problem by using the OECD's own estimates of the output gap, which are available for only a short period, the results are very similar to those when the HP filter is applied. However, this period is characterised by low inflation so this may reflect the time period rather than the method of estimating the output gap.

The most striking result, however, is that using real time data increases the apparent forward-looking weight as indicated by the Hybrid model. This confirms the results found for other countries, Orphanides (2001) for the United States and Huang *et al*. (2001) for New Zealand for example. In real time people do try to take into account other information about what is happening and likely to occur, which is not in the currently published statistics. After the event those statistics themselves can be revised as some of that extra information is revealed and any inconsistencies in the series become apparent. Thus using revised data the forward-looking element will be reduced.

Using real time instruments in GMM estimation instead of instruments based on revised data also has a clear impact on the structure of the Phillips curve. It lowers the weight on forward-looking expectations but gives higher and clearly positive output gap coefficients. In real time decision makers have to use noisy information without knowing what the noise is. If the instruments are revised to omit the noise they will be correlated with the errors and not so well correlated with omitted relationships like monetary policy that also have to rely on the noisy data.

The use of real time information in the Phillips curve confirms that the timing of expectations formation matters in inflation dynamics and that the euro area inflation process is not purely forward-looking. Similar to the experience for the US obtained by Adam and Padula (2003), where real time data from surveys are used to measure expectations, the Hybrid model with a lagged inflation term is needed to inflation dynamics properly. Although the estimation results are sensitive to the choice of the forcing variable and the output gaps, based on HP filtering, suffer from end point problems, we can say that the use of real time information makes a noticeable difference when explaining inflation dynamics. Revisions in this data set, even in the price series, are sufficient to matter.

The impact of Stage 3 of EMU in the EU has been characterized by three main features: a general improvement in monetary and fiscal policy among the OECD countries; a clear economic cycle, whose downturn appeared to reverse many of the gains made in the period of consolidation in an effort to qualify for admission to Stage 3 under the Protocol to the Maastricht Treaty; a clear change in behaviour, particularly in fiscal policy in recent years. However, many of these changes predate Stage 3 and began at the time of Stage 2 in 1995, when member states needed to prove their suitability to qualify. The clearest changes appear to have taken place in the determination of inflation and in monetary policy but to quite some extent the 'flattening of the Phillips Curve' represents the state of the economic cycle and a steeper segment is being revealed as the recovery continues. Expectations formation certainly seems to have changed and people have become more forward-looking. At the same time the distribution of behaviour among the various euro area countries has become smaller. Thus Europe is looking more like a single country than a group of different countries, even though there are still some striking differences. Even so, it is obvious that the role of monetary policy has rather increased than decreased, and, quite probably, the expectations channel has become more important.

Table 1 GMM estimates of a New Keynesian Phillips curve

	$\Delta_4 p(-1)$	$\Delta_4 p(+1)$	gap	SEE	J(6)
1975-1998	.533	.430	.003	.0127	9.49
	(65.81)	(9.64)	(0.16)		
1987-2006	.423	.422	.035	.0136	13.66
	(186.74)	(75.24)	(3.35)		
1987-1998	.502	.370	.067	.0130	11.08
	(17.61)	(20.30)	(0.78)		
1999-2006	.267	.397	.114	.0135	11.95
	(65.08)	(59.15)	(5.39)		

All estimates are Arellano-Bond GMM estimates with current and lagged values of import prices as additional instruments (in addition to the lagged values of the right-hand-side variables). First differences are used to take into account the cross-section fixed effects. Estimates are based on quarterly OECD data. None of the values of the J test are significant at conventional levels of significance. The data are for EU15.

Table 2 Estimates of a Phillips curve with the OECD forecast data

	Δp_{-1}	Δp^{e}_{+1}	gap	R^2/SEE	DW/J-statistic
F1, 1980-1998	0.380	0.684	-0.002	0.944	2.287
OLS	(7.45)	(11.53)	(0.03)	1.376	
F1, 1999-2006	0.347	0.649	0.121	0.600	1.760
OLS	(3.55)	(5.78)	(1.86)	0.835	
F1, 1980-1998	0.453	0.547	0.023	0.938	2.250
OLS	(8.98)		(0.51)	1.441	
F1, 1999-2006	0.345	0.655	0.119	0.600	1.761
OLS	(3.65)		(2.03)	0.831	
F1, 1980-1998	0.414	0.629	0.042	0.949	2.167
GLS	(10.73)	(13.01)	(1.20)	1.165	
F1, 1999-2006	0.402	0.604	0.118	0.702	1.935
GLS	(5.34)	(6.87)	(2.31)	0.831	
F1, 1980-1998	0.318	0.707	-0.072	..	..
GMM-AB	(4.92)	(9.27)	(1.08)	2.016	43.80
F1, 1999-2006	0.223	0.622	0.228	..	..
GMM-AB	(2.74)	(2.07)	(6.36)	1.187	25.49
F2, 1976-1998	0.424	0.618	-0.26	0.933	2.493
OLS	(8.21)	(9.94)	(0.55)	1.566	..
F2 1999-2006	0.244	0.762	0.088	0.706	1.909
OLS	(3.16)	(9.67)	(1.90)	0.716	..

F1 denotes the inflation forecast from June forecast and F2 the inflation forecast from December forecast. OLS denotes panel Least squares estimates (no fixed effects) and GLS generalized panel least squares (with cross-section weights) estimates. In the GMM Arellano-Bond estimation, the set of additional instruments include both the lagged values of the right-hand side variables and lagged values of F2. The instrument rank with the J-test is 12. Thus, the both J-statistics are significant although the one with the EMU sample has a marginal significance level over 1 per cent. With equations on lines 3 and 4, the sum of inflation variable coefficients is set to one. The data are annual and consist of the EMU countries only.

Table 3 When did the EMU show up?

	Quarterly data with GGM estimates		Annual data with OECD forecasts	
Starting year	Coefficient of Δp_{-1}	Coefficient of gap	Coefficient of Δp_{-1}	Coefficient of gap
1999	0.265 (65.08)	0.114 (5.39)	0.345 (3.65)	0.119 (2.03)
1998	0.209 (28.37)	0.055 (2.08)	0.420 (4.56)	0.130 (2.20)
1997	0.284 (29.30)	0.097 (7.32)	0.397 (4.83)	0.130 (2.29)
1996	0.293 (21.65)	0.065 (3.42)	0.373 (4.47)	0.147 (2.76)
1995	0.294 (7.15)	0.095 (2.09)	0.352 (4.31)	0.108 (1.89)
1994	0.342 (13.76)	0.058 (1.38)	0.361 (5.26)	0.091 (1.76)
1993	0.326 (8.87)	0.011 (0.15)	0.384 (6.09)	0.077 (1.58)

Selected parameter estimates for equation 4 in Tables 3 and 4. In all cases, the last period is 2006(Q4).

Figure 1. Expected Inflation

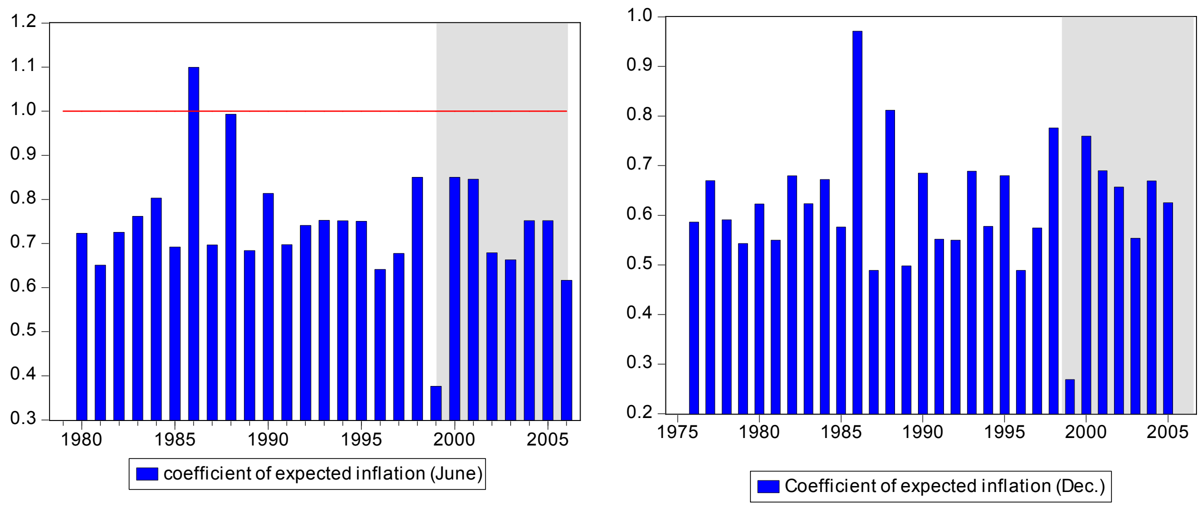


Table 4 Correlations and Test for Unbiasedness

(a) Correlations 1977-2002

GDP deflator	Revised	Forecast	Real time estimate
Revised	1	0.953	0.976
Forecast	0.953	1	0.963
Real time estimate	0.976	0.963	1
CP deflator*	*Revised*	*Forecast*	*Real time estimate*
Revised	1	0.955	0.991
Forecast	0.955	1	0.951
Real time estimate	0.991	0.951	1

* In all the tables *CP* denotes private consumption

Output gap	Real time HP filtered	Revised HP filtered	Revised OECD estimate
Real time HP filtered	1	0.604	0.577
Revised HP filtered	0.604	1	0.859
Revised OECD estimate	0.577	0.859	1

(b) Output gap correlations 1994-2002

Output gap	Real time HP filtered	Revised HP filtered	Real time OECD estimate	Revised OECD estimate
Real time HP filtered	1	0.679	0.873	0.627
Revised HP filtered	0.679	1	0.746	0.881
Real time OECD estimate	0.873	0.746	1	0.769
Revised OECD estimate	0.627	0.881	0.769	1

(c) Unbiasedness 1977-2002 (1994-2002 for OECD output gap)

Rows show estimates from equations of the form, $x_t = a + bx_t^*$ where x^* is the variable shown in column 1 and x is the most recent revised data for the same variable. The Wald test is of the joint hypothesis $a = 0$ and $b = 1$, which is asymptotically distributed as $\chi^2(2)$ under the null.

	Wald test		**a**	***s.e.***	**b**	***s.e.***
	Chi-Square	**Probability**				
Real time GDP deflator	0.204	0.903	0.038	0.106	0.999	0.013
Real time CP deflator	11.231	0.004	0.176	0.063	0.975	0.008
Real time HP filtered output gap	17.243	0.0002	0.496	0.122	1.038	0.083
Real time OECD output gap	4.137	0.126	0.365	0.185	1.133	0.096
GDP deflator forecast	11.751	0.003	0.007	0.149	1.043	0.019
CP deflator forecast	10.537	0.005	0.104	0.145	1.029	0.018

In all Tables, all euro area countries are included: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain but sample starts for Portugal only in 1980 and Luxembourg in 1982, so for the full data period it is slightly unbalanced. 'revised' indicates data as published in December 2003 OECD *Economic Outlook*, 'forecast' is forecast published in December OECD *Economic Outlook* of each year for the following calendar year, 'real time' indicates estimates of current year published in each December OECD *Economic Outlook*, with the exception of the HP-filtered output gap which is computed separately for each year by the authors from the entire real GDP series published in the December OECD *Economic Outlook*, including all past years, the estimate of the current year and the forecasts of the next two years. Real time estimates of lagged values, used in subsequent Tables are each drawn from the same December issue of OECD *Economic Outlook* as the current year estimate. They are not the series of current year real time estimates with lags applied. Prior to 1985 (1983 for France, Germany and Italy) the real time estimate of inflation two periods earlier is not available from *Economic Outlook* and is obtained from the issue of OECD *National Accounts* for each country in each year which most closely matches the December *Economic Outlook.*

Table 5 Estimates of restricted Hybrid model with HP filtered output gap (LS with Newey-West correction, 304 observations)

	Model	θ	s.e.	φ	s.e.	DW	SEE	Rsqr
1	*GDP, exp*	0.557	0.03	0.014	0.03	2.39	1.459	0.934
2	*GDP, exp, plag-realt*	0.551	0.04	0.018	0.04	2.04	1.465	0.933
3	*GDP, exp, plag-realt realtgap*	0.560	0.03	-0.028	0.06	2.04	1.465	0.933
4	*realtGDP, exp, plag-realt realtgap*	0.602	0.02	-0.098	0.03	2.13	1.107	0.960
5	*CP, exp*	0.567	0.02	0.070	0.03	1.95	1.100	0.962
6	*CP, exp, plag-realt*	0.584	0.03	0.064	0.03	1.74	1.167	0.957
7	*CP, exp, plag-realt realtgap*	0.613	0.03	-0.044	0.04	1.67	1.176	0.957
8	*realtCP, exp, plag-realt realtgap*	0.672	0.02	-0.138	0.03	1.84	1.146	0.960
9	*GDP, plead*	0.527	0.02	0.007	0.02	2.99	1.530	0.927
10	*GDP, plead, 2sls*	0.496	0.06	0.109	0.03	2.95	1.550	
11	*CP, plead,*	0.517	0.01	0.011	0.02	2.43	1.190	0.956
12	*CP, plead, 2sls*	0.522	0.04	0.116	0.04	2.36	1.220	

GDP: GDP deflator; *CP*: private consumption deflator. The following notation explains which series have been used in the model - *exp*: OECD forecast of inflation; *plag-realt*: real time prices for previous year; *plead*: most recent estimate of prices in next year; *plag*: most recent estimate of prices in previous year; *realtgap*: real time output gap estimates; *realtinstr*: real time instruments in GMM; *realtGDP*, real time GDP deflator; *realtCP*: real time estimate of private consumption deflator.

Table 6 Estimates of restricted Hybrid model (LS with Newey-West correction, 99 observations)

	Model	θ	s.e.	φ	s.e.	DW	SEE	Rsqr
(a) *using OECD estimates of the output gap*								
1	*realtGDP, exp, plag-realt, realtgap*	0.733	0.04	-0.020	0.02	2.41	0.589	0.896
2	*realtCP, exp, plag-realt realtgap*	0.582	0.04	0.071	0.02	2.08	0.547	0.902
3	*GDP, plead, 2sls*	0.466	0.06	0.088	0.02	3.13	1.084	
4	*CP, plead, 2sls*	0.475	0.03	0.086	0.01	2.60	0.594	
(b) *using HP filtered output gap*								
5	*realtGDP, exp, plag-realt realtgap*	0.710	0.02	0.035	0.03	2.41	0.589	0.896
6	*realtCP, exp, plag-realt realtgap*	0.585	0.03	0.142	0.03	2.08	0.535	0.906

See notes to Table 5

Table 7 Estimates of the hybrid model, GMM (304 observations)

row	model	θ	s.e.	φ	s.e.	J stat	p value	DW	SEE
1	*GDP, plead*	0.50	0.06	0.108	0.033	0.000	0.850	2.949	1.549
2	*CP, plead*	0.46	0.05	0.125	0.035	0.013	0.048	2.390	1.219
3	*realtGDP, exp, plag-realt, realt-instr, realtgap*	0.30	0.10	0.216	0.094	0.003	0.321	1.922	1.379
4	*realtCP, exp, plag-realt realt-instr, realtgap*	0.23	0.12	0.359	0.138	0.008	0.118	1.680	1.570

See notes to Table 2. Instruments: second lag of inflation and two lags of the output gap (revised data, rows 1 and 2, real time, rows 3 and 4). The standard errors of the estimated parameters were modified using a Bartlett kernel with fixed bandwidth (without prewhitening). In all cases, the Hansen test (J statistic) of the overidentifying restrictions of the model was used (Hansen 1982).

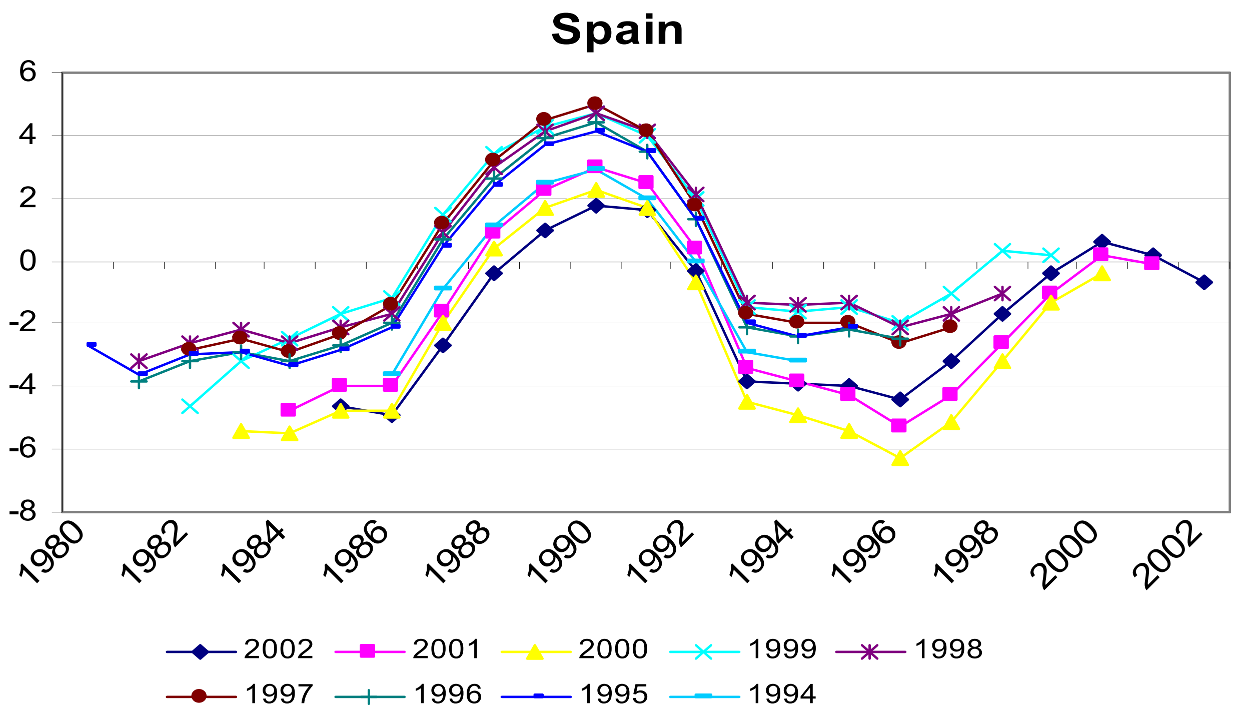


Figure 2 Real Time OECD Output Gap Estimates 1994-2002

Note: each line in the graph shows the estimates of the output gap published in OECD *Economic Outlook* in December of the year in question.

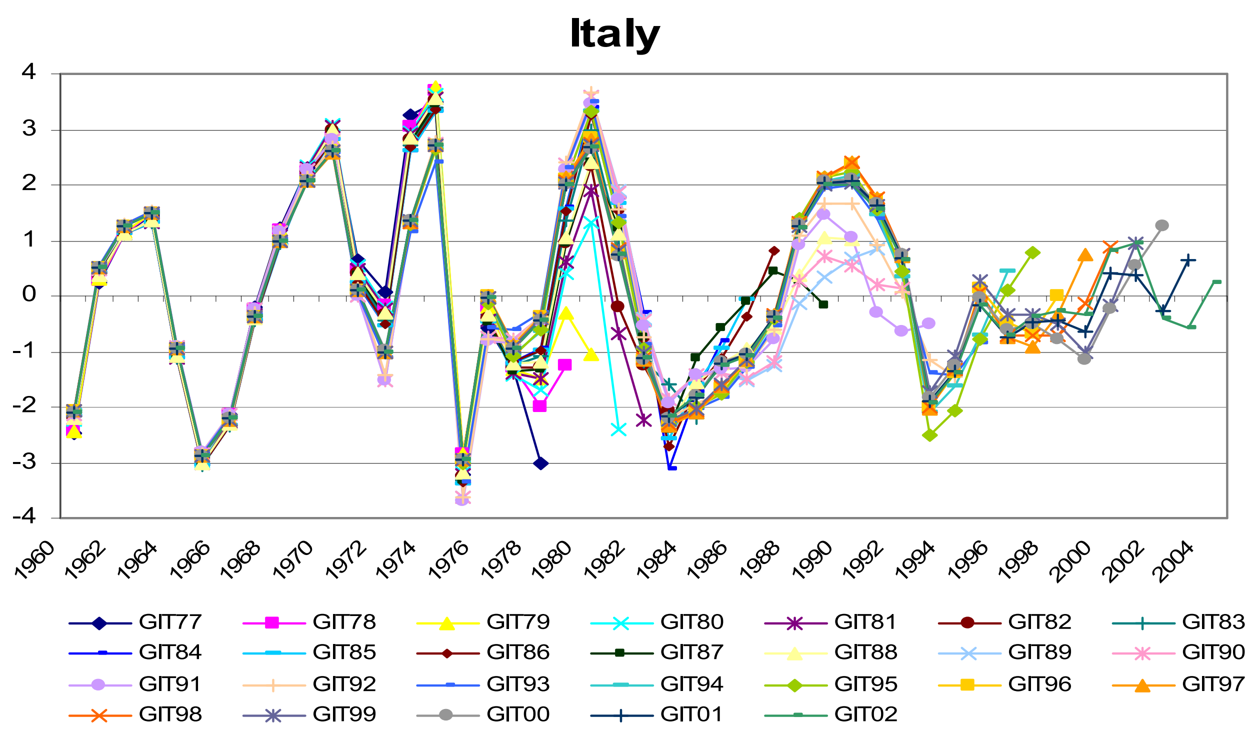
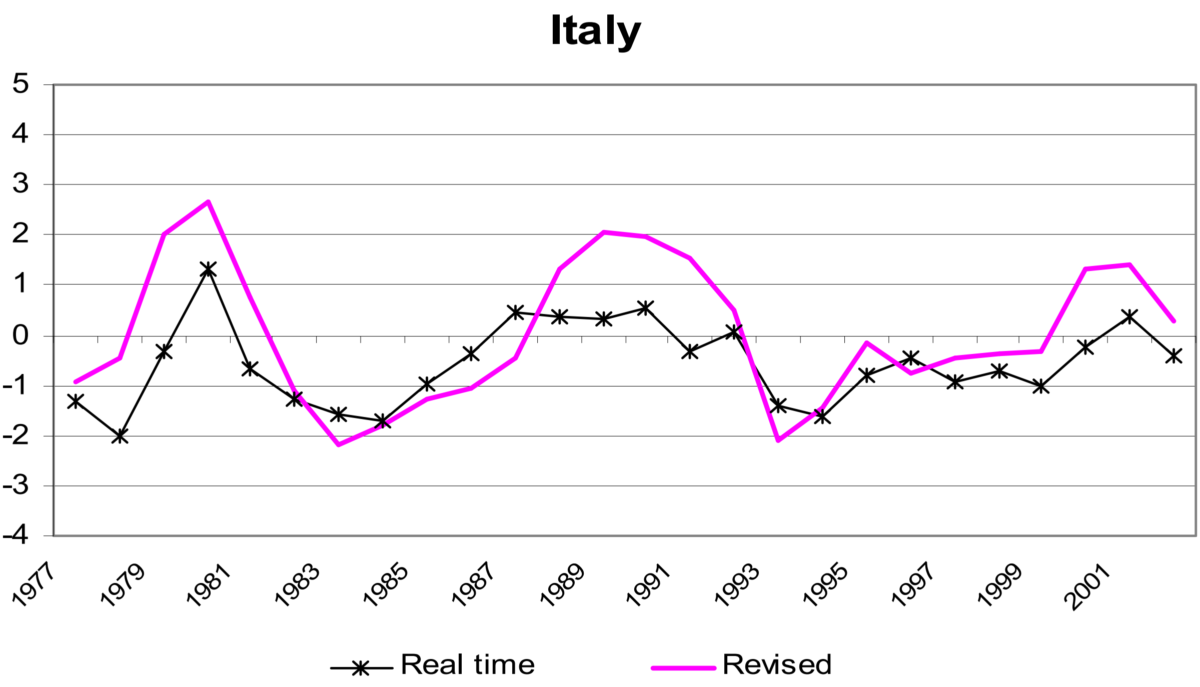


Figure 3 Real Time HP Filtered Output Gaps

Figure 4 Real Time and Revised HP filtered Output Gaps



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