BANK OF FINLAND
DISCUSSION PAPERS

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Asymmetry and the Problem of Aggregation in the Euro Area

SUOMEN PANKIN KESKUSTELUALOITTEITA • FINLANDS BANKS DISKUSSIONSUNDERLAG

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The views expressed are those of the authors and do not necessarily correspond to the views of the Bank of Finland

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We are grateful for comments from colleagues and from seminar participants at the Austrian National Bank.

ISBN 951-686-671-9
ISSN 0785-3572
(print)

ISBN 951-686-672-7
ISSN 1456-6184
(online)

Suomen Pankin monistuskeskus
Helsinki 2000

Asymmetry and the Problem of Aggregation in the Euro Area

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Abstract

This paper highlights the implications for EU macroeconomic policy at a relatively disaggregated level when key economic relationships are nonlinear or asymmetric. Using data for the EU and OECD countries we show that there are considerable non-linearities and asymmetries in the Phillips and Okun curves. High unemployment has a relatively limited effect in pulling inflation down while low unemployment can be much more effective in driving it up. Downturns in the economy are both more rapid and sustained in driving unemployment up than recoveries are in bringing it down. There is considerable variety in these relationships and in IS curves across not just countries but also sectors and regions.

Key words: aggregation, asymmetry, monetary policy, nonlinear models, Okun curve, Phillips curve

JEL codes: E52, D31, E32

Epäsymmetria ja aggregointiongelma euroalueella

Suomen Pankin keskustelualoitteita 11/2000

David G Mayes – Matti Virén
Tutkimusosasto

Tiivistelmä

Tutkimus valottaa EU:n makrotaloudellisen politiikan vaikutuksia suhteellisen disaggregoidulla tasolla tapauksessa, jossa taloudelliset riippuvuudet ovat epälineaarisia tai ei-symmetrisiä. Osoitamme käyttämällä hyväksi tilastoaineistoa EU- ja OECD-maista, että Phillipsin ja Okunin käyrät ovat huomattavan epälineaarisia ja ei-symmetrisiä. Suurella työttömyydellä on verraten vähäinen inflaatiota hillitsevä vaikutus, kun taas vähäinen työttömyys voi huomattavasti kiihdyttää inflaatiota. Talouden laskukaudet näkyvät sekä nopeammin että voimakkaammin työttömyyden kasvussa kuin nousukaudet työttömyyden supistumisessa. Näiden riippuvuuksien kirjo on huomattavan suuri ei pelkästään maiden vaan toimialojen ja alueiden osalta.

Asiasanat: aggregointi, ei-symmetrisyys, rahapolitiikka, epälineaariset mallit, Okunin käyrä, Phillipsin käyrä

JEL luokitus: E52, D31, E32

Contents

1 Introduction

The euro area has a single monetary policy for quite a diverse region. The range of that diversity is illustrated in Table 1 for inflation growth and measures of economic structure. 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,[1] some of the consequences of this for the setting of policy have been little discussed. Currently euro area policy simulations are either conducted with models that use euro level aggregated data or which handle the euro countries separately (with appropriate cross-country constraints) and aggregate the results.[2] 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 considerable asymmetries and non-linearities in inflationary behaviour and monetary transmission. 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.

1.1 Previous approaches

The existing literature on asymmetry and nonlinearity in behaviour can be conveniently divided into four groups:

1) that which seeks to demonstrate the existence of asymmetry in the behaviour of GDP and other macro-economic variables over time;[3]
2) that which seeks to explore the (non)existence of nonlinearity and asymmetry in specific relationships such as the Phillips curve and Okun curve,[4]

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[1] Dornbusch et al. (1998), Eichengreen and Wyplosz (1998), Obstfeld and Peri (1998) for example.
[2] The Bank of Finland's EDGE model (Kortelainen, 2000) follows the first approach and the NIESR NiGEM, the European Commission's QUEST II, and the Netherlands Bank's EUROMON the second, for example.
[3] Verbrugge (1998) and the references cited therein provide a helpful recent example, considering asymmetry in seven series across 22 countries. His results show various examples of asymmetries in both levels and growth rates but the most comprehensive example of asymmetry lies in consumer price inflation, which is our primary focus.

3) that which seeks to provide specific explanations of why such asymmetries and nonlinearities might exist. Only a few studies, Dupasquier and Ricketts (1998), for example, have been successful in attempting to provide a combination of the identification of the problem with its possible sources
4) that which concerns the policy implications (Clark et al. 1996, for example).

Most explanations of asymmetries in the business cycle focus on the labour market, however Chetty and Heckman (1986) and Baldwin and Krugman (1989) suggest that exit from industries may be less costly than entry.[5] In this paper we suggest that policy may also be asymmetric.[6] 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 intersectoral 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 Virén, 1998). 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 respond much more rapidly than the general price level to any change 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.

[4] See Yates (1998) and Eliasson (1999) for contrasting degrees of scepticism over the nonlinearity of the Phillips curve, for example.

[5] Mayes (1986) suggests that this applies to exit and entry from markets as well, particularly where this involves foreign trade.

[6] Monetary authorities may seek to offset the asymmetries in the inflationary process, while governments may be more concerned to combat high unemployment or take advantage of periods of higher growth (the 'inflation bias' discussed clearly in Walsh (1995) inter alia.)

1.2 The nature of asymmetry

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.[7] 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 Ball (1993) Mayes and Chapple (1995) discussion of the 'sacrifice ratio'. 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.

Eliasson (1999) and Dupasquier and Ricketts (1998) try to capture this complexity by not only allowing for nonlinearity in the Phillips curve but by also allowing either the basic parameters to change or additional variables to modify the relationship across both the cycle and over time. They and Yates (1998) provide a list of hypotheses for the causes under 5 main headings:

- Capacity constraints
- Confusion of aggregate and relative price shocks
- Adjustment costs[8]
- Downward nominal wage rigidity[9]
- Monopolistic competition.

It is possible to think of other explanations, such as the work of Gali and Gertler (1999) *inter alia* on the 'new' Phillips curve. However, the key message from this list is that a variety of departures from simple linearity and symmetry are possible and not just a 'straightforward' Phillips *curve* with an increasingly explosive price response as unemployment falls to very low levels and a negligible response as unemployment becomes very high. In the case of the Lucas (1972, 1973) 'signal extraction problem' of confusing aggregate and relative price shocks, the

[7] See Verbrugge (1998) for empirical evidence on these nonlinear properties in cross-country data.

[8] This is associated most frequently with the work of Ball and Mankiw (1995) on the case of 'menu' costs – there is a cost to changing prices some firms only do so when the need is substantial, generalised inflation makes this less necessary for downward adjustments. Similar arguments can be advanced for wage setting.

[9] Yates (1998) provides a very comprehensive attack both at a theoretical level and from evidence of others and his own empirical work that any downward rigidity is likely to be limited. His survey of 100 articles and papers on the topic is a valuable resource in its own right.

underlying ‘curve’ is linear but there will be departures from it when inflation is high.[10] In the case of the Stiglitz (1984) model of monopolistic competition the curve will actually be concave as firms will be reluctant to raise prices above current levels for fear of losing market share when others fail to follow and will be keen to lower prices to avoid being undercut.

The problem posed by aggregation in the face of asymmetry and nonlinearity can be regional as well as 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.[11]

1.3 The approach in this paper

Although previous analyses show the existence of the nonlinearities, asymmetries and aggregation problems we have described there does not appear to have been any systematic treatment of the three problems together using data for the whole euro area. In this paper, therefore, we consider the issues using a dataset that covers all of the EU countries except Greece and Luxembourg.[12] We thus cover not merely the current euro area but also the main countries that might join it over the coming few years.

Our concern in this paper is thus three fold.

– In the first place we want to explore how widespread and important the problems of asymmetry and nonlinearity are in the euro area. Our primary approach to asymmetry is to use a threshold model, splitting behaviour into two regimes (Tong, 1983), although we do consider alternative specifications (Harris and Silverstone, 1999a,b, for example). To do this we consider three main macro-economic relationships: the IS curve, in Section 2, the Phillips

[10] There are of course strong supporters of the view that the Phillips curve is in practice linear, ‘resolutely’ so in the case of Robert Gordon (see Gordon (1997) *inter alia*).

[11] 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.

[12] The data for Ireland are more limited and Greece and Luxembourg only excluded because the data were not available.

curve in Sections 3 and 4 and finally the Okun curve in Section 5. Our approach to nonlinearity in these relationships is conventional.[13]

– Secondly, we wish to try to tie down where the asymmetry comes from and how it is propagated across the economy. We consider, first of all, whether it comes from the price setting mechanism, wage formation or the operation of policy. Secondly we explore the extent to which it may be due to sectoral and regional differences in behaviour. In particular, we explore whether it is due to differences in the responsiveness of the sectors of the economy to internal and external shocks (drawing on our earlier work in Mayes and Virén, 2000). We also consider whether it is due to the regional and sectoral distribution of unemployment/vacancies and not just to their levels. We build on the work of Lilien (1982) and Haltiwanger and Schuh (1999) in exploring the degree to which mismatch or the rate of turnover in the labour market may lead to departures from linearity.
– Lastly we consider the implications for policy in Section 6, drawing out in particular the problems facing a single monetary policy for the euro area. If relationships are nonlinear, behaviour asymmetric and variable across the member states, then considerable care is required in aggregating to determine the appropriate policy setting for the area as a whole. It may be that policy preferences and reactions themselves should be asymmetric (Waud, 1970; Virén, 1993).

In order to explore the extent of this problem of variety of behaviour we use three different forms of disaggregation:

– national data in the form of a panel
– sectoral data within the economy
– regional data at the NUTS3 level.

Between them this should provide a comprehensive view.

2 Aggregation

2.1 An example from IS curves used in computing MCI ratios

Before adding the complication of asymmetry we consider the importance of aggregation separately in the case of a linear model relating to monetary policy decisions. In Mayes and Virén (1998) we provided estimates of an MCI (Monetary Conditions Index) for the euro area using a variety of models. The interest in estimating an MCI was to get an indication of the relative importance of the (real) exchange rate and (real) interest rates in the transmission of monetary

[13] Between them these three relationships form the basis for a simple but reasonably complete macroeconomic model, explaining output, unemployment and inflation, when combined with a policy reaction function to determine the interest rate. It would, however, be an order of magnitude more complex to treat this as a single system and at this stage, therefore, we have dealt with each relation separately. The more complete approach remains for further work.

policy through to inflation.[14] The MCI summarises in a single index the joint effect of the two channels through to inflation. It does not of course include other transmission channels such as the direct effect on expectations or the credit channel (Mishkin, 1995). It is formed as the weighted sum of the two components where the weights are determined by the relative impact of the two channels on demand pressure.

Let us illustrate this with the simplest of the models, which was an open economy IS curve of the form

$$\nabla y_t = a_0 + a_1 \nabla y_{t-1} + a_2 \nabla y_{t-2} + a_3 rr_{t-i} + a_4 re_{t-j} + a_5 \nabla y^*_{t-k} \tag{2.1}$$

where ∇y is the deviation of output from its Hodrick-Prescott filtered trend, rr is the real 3-month interest rate, re the real exchange rate with the US dollar (in logs) and ∇y^* the deviation of OECD output from its HP trend (for definition of variables see notes on the relevant Tables). Lag lengths i, j and k typically vary from 1 to 3 quarters. This is very similar to the equation used by Duguay (1994) in the original formulation by the Bank of Canada. The interest rate and exchange rate coefficients a_3 and a_4 suitably normalised provide the weights. The MCI ratio is computed simply as the ratio of the two coefficients, a_3/a_4.

In order to provide a suitable estimate for the area as a whole we estimated (2.1) for each of the euro countries excluding Luxembourg (see Table 2) for the period 1987.1 to 1997.4. In order to compute an estimate for the euro area as a whole we simply aggregated these estimates using GDP weights. From this we can see that there is considerable variation across countries (Fig. 1 last col.) but also a concentration round the aggregate estimate of 3.5. If on the other hand we had assumed that parameters were the same across the euro countries, which we do in Table 3 by treating the data as a panel we can see that the results change and lower estimates are obtained in each case, although not strikingly so. Note that lower estimates imply that the exchange rate is even more important in the monetary transmission mechanism than we previously estimated. It is interesting to note from Row 3 of Table 3 (EU13) that adding the EU countries that are not currently members of the euro area (excluding Greece) has almost no impact on their relative responsiveness to the exchange rate although the estimate becomes rather more closely determined. However, when GLS or SUR estimation is applied the estimates become considerably smaller, smaller even than those in Dornbusch *et al.* (1998), and imply an implausibly open euro economy. Imposing similarity of behaviour on this definition of the EU would thus tend to generate inappropriate conclusions for policy and is clearly rejected by the data.

However, while there are clear problems in adding up the ratios, computing the level of the MCI is much more difficult if the economic cycles of the Member States are not in phase, as it is the output gap which is relevant to their assessment. In such a case it would be inappropriate to estimate an MCI using aggregate data for the euro. Instead separate MCIs should be estimated at the

[14] Both the use and estimation of MCIs are controversial (see Eika et al. 1997 and Mayes and Virén, 2000, for example) but this does not concern the present discussion.

disaggregated level and then aggregated.[15] This is particularly important if the short-run Phillips curve is not linear and positive output gaps have a much stronger impact on increasing inflation than negative gaps have on decreasing it. We, therefore, return to estimate the Phillips curve in Section 4.

This problem of aggregation under nonlinearity or asymmetry does not merely occur when trying to aggregate across different economies. It exists within economies as well.

2.2 The same aggregation problem within economies

To give an indication of the importance of economic structure in the estimation of the MCI we disaggregated Finnish GDP into 8 main sectors, shown in Fig. 2, and estimated sectoral MCIs of the same form. As might be expected it is the highly traded sectors where the MCI is lowest: manufacturing, forestry and agriculture; and the resident sectors such as construction and hospitality where the MCI is higher.[16] The immediate result is that differences in the relative impact of the interest rate and exchange rate channels of the transmission of monetary policy vary almost as much by sector as they do by country. Even if country variations in the MCI might be expected to fall as integration proceeds in the euro area, sectoral variations are likely to continue. However, increased openness will tend to make all sectors increasingly 'tradeable' even if their outputs are not readily traded. This will tend to lead to decreasing values for the MCI. At the same time, the transmission mechanism through the exchange rate will also be affected by the introduction of the euro. Area-wide trends would affect the average MCI ratio but it will depend upon the correlation between the innovations in the exchange rate and interest rate mechanisms in the individual countries as to whether their specific MCI ratios would fall or rise.

The same pattern emerges at the European level. Using the same panel of countries as in Table 3 we have also estimated IS curves at the sectoral level, for just four sectors: Agriculture, Industry, Construction and Services.[17] The estimated MCIs follow the same pattern as before in order of decreasing openness: agriculture 1.0, industry 2.2, services 4.7 and construction 18 (see Fig. 3). However, the equation for agriculture is not well determined nor is the exchange rate coefficient for construction. Hence if shocks are sectoral their impact for monetary policy will be considerably different than if they are spread evenly across the whole economy.

Thus it matters for policy, not merely whether shocks are unevenly spread across the member states of the euro area but whether they are spread unevenly

[15] It is not of course self-evident that it is the Member State level that is appropriate for the disaggregation. It should really be regions in which behaviour is fairly homogeneous. (Dupasquier, Lalonde and St-Amant (1997) demonstrate that in some cases there is more variation between some Canadian provinces than there is between Canada and the US.) Commodity price shocks may have regional rather than national impacts. However, the data to hand are on a Member State basis.

[16] In estimating the differential effect of shocks to the exchange rate on the various parts of the euro economy, regard will have to be paid not just to the country composition of trade for the various parts of the area but also to their industrial structure.

[17] It was not possible to get disaggregated data for the period for Belgium or Ireland. Row 2 of Table 2 therefore shows the aggregate results for the remaining 11 (EU11) countries. The estimates are very similar to the other two aggregates of 10 or 13 countries.

across industries. Or turning this argument round, the impact of a common shock will vary both by member state and by industry.

3 Nonlinearity and asymmetry

The archetypal nonlinear relationship in macroeconomics is the Phillips curve (Phillips, 1958). Indeed it is only partly an accident of history, with the collapse of the long run regularity and its replacement with a short-run expectations augmented curve (Phelps, 1967) that it should have been estimated as a straight line. Moreover the term 'Phillips curve' has been extended to include any relationship between some measure of excess demand/supply in the economy and a measure of inflation, rather than just the relationship between unemployment and wage inflation. In this section we focus on one of the more common variants, the relationship between the output gap and price inflation, as this has frequently been estimated in linear form (see Clark and Laxton, 1997, for a brief review and alternative approach).

In its simplest form the relationship is usually represented in linear form as

$$dp = a_0 + a_1 dp_{t-1} + a_2 dp^* + a_3 \nabla y + u \tag{3.1}$$

where p and y are defined as before but ∇y denotes an output gap, p^* is the foreign price (in domestic currency). In the estimated model a Hodrick-Prescott filter is used to estimate the trend. We introduce a forward-looking expectations augmented version of (3.1) in the next section when the data permit, rather than this purely adaptive approach.

We develop this linear model into a nonlinear form by using a so-called 'threshold' model (see Tong (1983) and Granger and Teräsvirta (1993) for details). In essence, the specification requires piecewise linear estimation of the output gap variable so that ∇y is replaced by the two separate terms ∇y^+ and ∇y^- where ∇y^+ denotes the values of ∇y that exceed a certain threshold value (which may be zero). Accordingly ∇y^- denotes the remaining values of ∇y.

Obviously we could have more that 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) which is also used by Eliasson (1999). The lack of sufficiently long time series also made this alternative less appealing and hence we used the much simpler Phillips curve of the form

$$dp = a_0 + a_1 dp_{t-1} + a_2 dp^* + a_3 \nabla y^+ + a_4 \nabla y^- + u, \tag{3.2}$$

where $\nabla y^{+/-}$ denotes the values of the output gap when it is (positive/negative).[18] Fig. 4 shows the results for the EU countries in our sample, for the shorter data period 1987–1997.[19] Again, with the exception of Spain and Finland the results conform to the expected asymmetry. A more complex analysis taking into account the cyclical position in each member state may thus needed before the level of the MCI is going to have a reliable or transparent meaning.

If we take a very simplified example as shown in Fig 5 it is very obvious how ignoring asymmetry and aggregation problems could have an unfortunate effect for policy. Let us assume first of all that the relationship between inflation and the output gap is as shown by the curve in the figure. Then simple arithmetic aggregation of forecasts of the output gap for two countries/regions/industries, which generate two expected outcomes, one at A and the other at B, will give a result such as 'gap' shown on the horizontal axis (even if weights are used). Assuming the relationship is a straight line will result in forecast inflation being $\Delta p1$ rather than the appropriate value $\Delta p2$. Under an inflation targeting regime this will tend to mean that the policy response will be rather harsher under the assumption of a linear relationship than it should be. Indeed in the case illustrated, the correct policy decision would be to ease while the actual decision, wrongly assuming linearity, would be to tighten.

We have chosen the deliberately simplified case where both A and B are on the linear as well as the curvilinear relationships. In general the contribution of large negative output gaps to holding inflation down will be overestimated and the contribution of high positive gaps to driving inflation up will be underestimated.

However, this is assuming that there is a common relationship, which applies all of the euro economies. There is considerable evidence that there are important differences in the transmission mechanism across the member states. *As a result one is not only trying to add inputs where the relationships are nonlinear but where the nonlinearity itself varies. We thus need to consider where each of the countries is on its own curve and add together the change in inflation that would stem from the impact of the single monetary policy on each country's output gap and then aggregate.* From a practical policy point of view the use of a single linear relationship will only generate significant errors, if

– the shifts along the curves are expected to be substantial
– the nonlinearity is considerable
– the different countries have very different output gaps (their cycles are not well coordinated)
– the individual country relationships are very different from each other.

For the results shown in Table 4 we have employed a slightly more complex lag structure allowing two lags for both consumer and foreign prices, which we have here measured as import prices, so as to give a clear idea of the weighting that

[18] There are obviously several other alternatives for specifying a nonlinear relationship between Δp and ∇y. Perhaps the most common alternative is to use an additional quadratic term in ∇y. This alternative would, however, imply a symmetric response of inflation to changes in output and hence this alternative is not so useful. Also the economic interpretation of the eventual nonlinearity (e.g. in terms of price rigidities) will be more difficult in this case.

[19] Estimation of specifications like (3.2) is quite straightforward but testing for the threshold is much more complicated, even though we treat the threshold value as a nuisance parameter (see Hansen (1999) for details. In particular, in the case of heteroscedasticity, the conventional percentage points of the F distribution can be quite misleading.

applies to the foreign price structure for each country. It is immediately clear from the first four rows of the Table that the hypothesis of symmetry is rejected whichever estimation method is used. GLS and SUR make the picture rather clearer yet do not weaken the overall explanatory power. In each case the positive output gap shows a clearly positive relationship, while the negative output gap does not appear to exert any significant influence on inflation either upwards or downwards. The estimated coefficient for the constrained linear relationship shown in the first row not surprisingly lies between these two extremes. The results for the panel data for the EU show a rather firmer dichotomy than did the simple individual country model (see Fig. 6).

We now have a striking implication for policy. *When the output gap is negative this will exert very little downward influence in its own right on inflation. Attempts to run the economy in over expansionary manner will on the other hand have substantial and quite rapid effects on inflation.* There is therefore a strong incentive to avoid inflationary pressures taking hold. With this asymmetric model the costs of pursuing a price level as opposed to an inflation target could be considerable. Yates (1998) questions the existence of downward rigidity in nominal prices and wages[20] and hence one might wish to attribute our observed relationship to a different source. Yates himself points out that the shape may reflect the reaction of the authorities.[21] There is certainly little reason to think that the euro area has suffered from a 'lower bound' problem in the period we are looking at.[22]

The choice of a zero output gap as the point round which to split the data is somewhat arbitrary. Although by construction of the output gap variable this will be a split around the mean value. Other splitting points might perform better empirically but a search over the range reveals that the errors are minimised at a value of –0.005 for the output gap. Not only is this virtually the same as zero but the coefficients in the equation are largely unaffected (Table 4, row. 4).

If we assume that the actual relationship should be a curve and that there is unlikely to be any sharp regime shift around the zero gap then this model will tend to underestimate the importance of the output gap for small negative values and overestimate it for small positive values.[23] Values nearer the original single line will tend to be most appropriate. At large negative and positive gaps the misestimation will be the other way round. The line will overestimate the importance of large negative output gaps and underestimate the importance of

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[20] Real rigidities can, however, be overcome even in the case of downward nominal rigidity through changes in the exchange rate.

[21] Yates (1998) generally finds that the Phillips curves he estimates are not very well determined even before trying to add evidence of nonlinearity. While the nonlinearity may have the expected sign in many of his estimates it is not normally significant despite specification searches.

[22] These problems are extensively discussed in the papers presented at the conference on 'Monetary Policy in a Low Inflation Environment', Federal Reserve Bank of Boston, October 18–20, 1999.

[23] Pyyhtiä (1999) using a similar model but with fewer countries and semi-annual data (without lags) obtains similar results for the pooled model. When the individual countries are estimated separately the pattern of the coefficients is similar in all cases, with positive gaps having a greater effect than negative gaps. Only in the case of Germany does the coefficient for the negative gap approach significance but the positive gap coefficients are not particularly strong except in the case of Italy. However, Pyyhtiä's main focus is on a curvilinear specification, using a quadratic representation of the output gap. Adding the quadratic term improves the explanation for 5 out of the 7 countries in the sample but the findings are relatively weak even in the pooled case.

large positive gaps, possibly exponentially so, depending on the shape of the curve, as limits are likely to be approached in both dimensions.[24]

If we consider the implications for policy at a national rather than euro area level. Countries with positive output gaps should have a much more important influence on monetary policy than those with negative gaps. Or turning the argument round, if policy is set symmetrically it will tend to have an inflationary bias (see Clark *et al.* (1996) for a clear description).

4 The problem at the regional level

One of the most important explanations of nonlinearity and asymmetry that we cannot explore with aggregate data is that it is related to structural change or the degree of mismatch in behaviour across sectors or regions.[25] The most obvious way to reformulate the problem is to disaggregate the data one step and look at regional data within each country.

Unfortunately it is relatively difficult to disaggregate, as regional data do not cover the same variables particularly well. We have therefore used the nearest information readily available. This is drawn from the Eurostat Regio database at the NUTS3 level for the EU.[26] NUTS3 has some 251 regions for this subset of countries. The data are annual running over the years 1984–1998. Not all years are available for each country so we only obtain some 153 observations out of the potential 180. In this case we use a different approach to the problem and consider not just the level of unemployment but its distribution across the regions. The hypothesis is that the greater the range/variance of unemployment at any given level of average unemployment then the more inflationary will be the impact as the low unemployment regions will contribute to inflationary pressure for the EU as a whole. This can be regarded as an extension to the Lilien index (Lilien, 1982; Mayes and Silverstone, 1998)

$$L = \sqrt{\left[\Sigma_i w_i \left(e_i - E\right)^2\right]}, \tag{4.1}$$

where e_i is the rate of growth of employment in region or sector i and E is the growth of employment in the area as a whole, w_i being the weight, the share of employment in that region in the total. Lilien's hypothesis is that the greater the dispersion of growth rates in employment the higher is likely to be the unemployment rate. This reflects the idea that it is costly to retrain or move labour. Purely macroeconomic statistics will cover up the consequences of this. If growth is not evenly spread then the more rapidly growing regions will not be as

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[24] We tried moving one step closer to estimating a curve by using a three-facet curve. With such a small dataset it is not surprising that the parameters were not well determined but the result did suggest that a smoother transition might be more realistic.

[25] A fairly extreme example of how different the regional effects can be is shown in Buxton and Mayes (1986) using UK regional data, where the region with the lowest unemployment (the South East) is shown to have a major impact on wage inflation. More than that it appeared to be short-term unemployment that had the effect. Those employed for a year or more appeared to be effectively out of the labour market from the point of view of affecting the inflationary process.

[26] Greece, the Irish Republic and Luxembourg had to be excluded through lack of data.

successful in reducing unemployment elsewhere as the less rapidly growing regions are at creating unemployment.

We are not able to formulate the problem in quite the same dynamic context and consider the variance in unemployment across the regions instead. Here the argument is a little different. Following our aggregate findings for a nonlinear Phillips curve we would expect that regions with high unemployment tend to have relatively little impact on reducing inflation, whereas regions with low unemployment have an increasingly positive effect as unemployment falls. Measures of variance are a second best for our purpose as they are symmetric. Nevertheless, a wider range or standard deviation will tend to indicate the existence of these lower unemployment regions compared to the average and hence a greater impact on inflation for any given level of unemployment for the country as a whole.

We are able to improve on the simple forms of the Phillips curve used in Fig. 4 and Table 4 as we now have annual data. This allows us to incorporate a measure of expectations directly into the relationship

$$\Delta p = a_1 \Delta p^e + a_2 \Delta p_{t-1} + a_3 \Delta m + a_4 U + a_5 Udisp + a_6 t. \quad (4.2)$$

Rather than solve out some backward-looking approach to expectations we have included a forward-looking estimate of Δp^e using the forecasts that the OECD publishes annually for the year ahead. Although picking on any one forecaster is inherently arbitrary we have used the OECD for three main reasons. Firstly, because the OECD uses a common methodology for each country there is a degree of coherence across the different countries in our sample. Secondly, although subject to political pressures the OECD view is likely to be fairly widely shared and respected. Lastly, because a formal methodology is employed there is likely to be some coherence over time.

We have been able to use two measures of variance of unemployment levels across each country, Udisp, the range Umax–Umin and the standard deviation Usd. Lastly (4.2) also contains a measure of the main other influence on inflation in open economies namely import prices, m.[27]

We can see from Table 5 that the hypothesis is borne out whichever of the two unemployment variance measures is used. Variance in unemployment across regions has a positive effect on inflation. It is also clear from the comparison of columns 1 and 3 and 2 and 4 that the individual member states react differently. Inserting shift dummies into the equation improves the fit of the basic Phillips curve considerably, increasing the (negative) impact of average unemployment substantially while also increasing both the size and the significance of the positive impact of the spread.[28]

In column 6 of Table 5 we try adding the asymmetry in the Phillips curve itself by replacing the single (linear) relationship by a two-piece linear relationship, allowing the relationship to be differ according to whether unemployment is above or below a threshold value. Using ML to estimate a value that maximises the likelihood gives 10.8 % for the threshold, somewhat higher than the average value of unemployment of 8 % for the period as a whole. The

[27] We have not attempted to include further variables to remove the effect of specific shocks such as oil price rises but there is a strong downward trend in inflation in many countries over the period, which needs to be accounted for if the relationship is to be meaningful.

[28] Clearly, the results are consistent with Buxton and Mayes (1986), discussed in Section 1.2.

difference in slope of the two coefficients is not substantial but it is significant at the 1 % level. The results follow the expected convexity with the effect of unemployment on inflation being greater at lower levels of unemployment and weaker at higher levels.

In the second half of Table 4 we show the effects of extending the Phillips curve estimation to the same sectoral data that we used for the IS curves in Table 3. The model is identical to that used in Table 4 but the output gaps are computed for each of the sectors individually rather than for the whole economy.[29] For all four sectors the impact on inflation is higher when there is a positive output gap (see Fig. 7). In each case the positive segment coefficient is clearly significantly different from zero. In the case of agriculture and construction the impact is relatively limited. The negative segment coefficients are close to zero and poorly determined, with the exception of services where there is a moderate affect. The sectoral distribution of any excess supply thus has an effect on the overall outcome. Since shocks have differential effects across sectors we would expect this to have differential effects on inflation and hence on monetary policy.

Clearly to quite some extent this is illustrating what we know already as these asymmetric impacts would be picked up by other aspects of macroeconomic models. Sectoral shocks would have differing effects on the exchange rate or import prices for example. *Nevertheless these results make it clear that neglecting the distribution of the impact below the EU level could have misleading implications for policy, whether the neglect was national, regional or sectoral.* Even within smaller countries the distributional differences still matter.

Our results seem to be a little more robust to the finding of asymmetry and nonlinearity than some other recent studies. In their work on asymmetry and nonlinearity in the Phillips curve, Laxton *et al.*[30] find that while the evidence supports the existence of convex relationships between inflation and unemployment in an expectations augmented specification, the convexity is not strong over the policy relevant range and the evidence relatively weak.[31] Indeed they conclude (Laxton *et al.* 1997, p. 43) 'standard empirical techniques are not likely to be capable of providing a reliable answer on the functional form'. However, in no case is the convex relationship rejected by the data. They use both the regime change model we employ and a continuous curve and consider the US, UK and Canadian economies. McDonald (1997) and Razzak (1997) find similar relationships for the Australian and New Zealand economies.

One of the difficulties about measuring these relationships is that in practice the observations that we have are 'policy inclusive'. Over the period governments have sought to stabilise the economic cycle with some combination of monetary and fiscal policy, partly through 'automatic stabilisers' and partly through discretionary action on each occasion. Laxton *et al.* (1993) argue that this will tend to reduce our ability to observe the curvature of the relationship. Not only does it inhibit the variance but it reduces the impact of the underlying relation. However, the impact of policy could be even more distorting if policy is itself not symmetric or linear. Economists typically express loss functions in quadratic terms implying that policy will respond more than proportionately as expected outcomes deviate from their targets. However, they tend to make them symmetric

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[29] Inflation also relates to the sectoral prices.

[30] Laxton, Rose and Tetlow (1993); Laxton, Meredith and Rose (1995); Clark, Laxton and Rose (1996); Debelle and Laxton (1996); Clark and Laxton (1997); Laxton, Rose and Timbakis (1997).

[31] The authors use both piecewise linear and curvilinear specifications.

(Taylor, 1993). It is perhaps a little more realistic to consider the ‘opportunistic’ approach to policy (Orphanides and Wilcox, 1996) where ‘favourable’ outcomes such as more rapid recoveries, balance of payments improvements etc. than expected are accepted and not offset, whereas less favourable outcomes stimulate further policy responses. A more general asymmetric loss function is used in Koskela and Virén (1990) and Virén (1993) drawing on the work of Waud (1970) and Hosomatsu (1970). This also applies the threshold model approach that we have used in this paper.

Inside the euro area the convexity will have a particular effect if the various member states are out of phase in their economic cycle or have been subject to asymmetric shocks that require structural adjustment that may be slow to come if there is substantial hysteresis in the economy. The economies that are suffering a negative output gap will be doing less to bring inflation down than the economies with the positive output gaps are providing upward pressure. Therefore in general the more asynchronous the euro area turns out to be the tighter monetary policy will need to be compared with any given growth rate for the area as a whole. If cycles are asymmetric in the sense that it tends to be more difficult to get out of recessions then the problem will be exacerbated.

5 The Okun curve in the OECD

These concerns about nonlinearity are not confined to Europe nor to the Phillips curve. Another example is the Okun curve, which has been subject to a number of recent studies (Attfield and Silverstone, 1998; Harris and Silverstone, 1999a,b; Kaufman, 1988; Moosa, 1997, Palley, 1993, Prachowny, 1993 and Weber, 1995, for example). Silverstone and Harris (1999b) find asymmetry of some form for Australia, Japan, New Zealand, the UK, US and West Germany over the period 1978 to 1999. However, the finding is not universal and they cannot reject the null hypothesis of symmetry for Canada over the same period. Perhaps more interesting is the much more detailed treatment of the relationship by Haltiwanger and Schuh (1999), who introduce sector specific factors to help explain the lack of symmetry. We deal with the aggregated relationship first.

The Okun curve (Okun, 1962) is normally expressed as the relationship between the change in unemployment and the percentage change in real output in the economy

$$\Delta U = c_0 + c_1 \Delta Y / Y. \qquad (5.1)$$

However, it is also argued (see Prachowny (1993) for example) that some scaling of the labour variable is required so in our formulation we have also included population of working age, POP.[32] The curve may therefore offer some additional insight into the nonlinear operation of the labour market to augment the Phillips curve results of the previous section. Both employment and unemployment appear to respond in an asymmetric manner to demand shocks.

[32] Prachowny (1993) employs a rather more elaborate transformation, incorporating the Okun curve into a production function and considering linear discrepancies of the factors of production from their equilibrium values as well.

We focus on the Harris and Silverstone approach as rather than estimating a curve or piece-wise linear function they build the asymmetry into the error correction mechanism, assuming that there are different correction paths depending upon whether real output is above or below its trend value. In effect, therefore this gives us three different ways of handling the asymmetry. The first, following Kim and Nelson (1999) is to assume that although the function itself is linear, we should treat potential output more in the form of a frontier, very much along the lines of frontier production functions (Aigner *et al.*, 1977; Mayes *et al.*, 1994; Mayes, 1996). This provides a direct extension to Prachowny's (1993) production function basis for the Okun curve. Here the errors in the relationship can be decomposed into a symmetric term e and a non-symmetric term v, which permits a longer tail of values when the economy is operating inside the frontier. Thus in the case of (5.1) the error term u in the estimated relationship

$$\Delta U = c_0 + c_1 \Delta Y / Y + u \tag{5.2}$$

would be composed u = v + e, with e ~ N (0, σ_e^2) and v ~ M (μ, σ_v^2) where M is a nonsymmetric distribution.[33]

The second approach, used by Harris and Silverstone (1999a,b), is to estimate the cointegrating relationship in (5.1) and assume that the error correction mechanism ε

$$\varepsilon = U - \hat{c}_0 - \hat{c}_1 y, \tag{5.3}$$

where ^ denotes an estimate, can be divided into ε^- where $\varepsilon < 0$ and ε^+, where $\varepsilon \geq 0$. The coefficients on ε^- and ε^+ are then not constrained to be equal in the adjustment process.

Our approach and that of Laxton *et al.* (1997) and Pyyhtiä (1999) is to treat the relationship itself as being nonlinear and hence we use the more conventional threshold model in terms of output growth

$$\Delta U = c_0 + c_1 y^+(t) + c_2 y^-(t) + c_3 \Delta pop + c_4 \varepsilon_{-1} + u_t. \tag{5.4}$$

In (5.4) y is the growth rate in GDP, pop the population of working age and ε the error correction term defined in (5.3) (lagged one period). t is a threshold value for the asymmetry. There are a number of routes to determining this threshold. One would be simply to use a simple form of output gap, although since our data are annual this would entail a fairly trivial definition of potential output, such as the mean rate of growth over the sample period. We show the effects of setting t equal zero so that we distinguish actual recessions from other behaviour and determining the maximum likelihood value for t. In the second case the outcomes tend to be near the mean.

Each of the three approaches gives a somewhat different flavour to the problem.

In our own work, reported in Table 6 we have used both a longer data series and a wider range of countries from Silverstone and Harris (1999b). While we did experiment with a split error correction term it appeared that incorporating the

[33] In line with the early frontier production function literature Kim and Nelson (1999) assume that M is half Normal, Mayes *et al.* (1994) also consider the more general case of a truncated normal.

asymmetry into the coefficients of the equation was a rather better determined approach. Different speeds of adjustment alone had lower explanatory power and added little when the output coefficient spilt was already present. In part this may be due simply to the use of annual rather than quarterly data. The Table shows estimates of simple Okun curves for 21 countries from 1961 to 1997.[34]

Only in the case of the UK and Japan do we find that there seems to be little relation between output and unemployment when using a linear formulation of (4.1).[35] However, the relationship for New Zealand is weak (a very different result from that found in Harris and Silverstone, 1999a). Once we introduce the asymmetry, most countries produce the positive and negative segments with different slopes and show the expected asymmetry very clearly. If we separate out the data according to whether or not the economy is in recession[36], cols. 1 and 2 in Table 6. In 14 of the 21 cases the coefficients are larger when the growth rate is negative. In other words unemployment rises more when the economy contracts than it falls when the economy expands. This fits with our expectations about hysteresis. However the differences are not in general significant. Of the seven cases that do not conform to this pattern, Finland shows no asymmetry, the US shows the reverse asymmetry but with appropriately signed coefficients, while Greece, Italy and Japan have perversely signed coefficients for the negative segment. *However, in each case the likelihood ratio test does not lead us to reject the symmetric relationship. Symmetry is also rejected in the case of the UK but here the negative segment also has a perverse coefficient.*

If on the other hand we split the relationship at the point which maximises the likelihood function then only five cases show coefficients where the effect on unemployment is smaller (less negative) below the threshold (cols. 3 and 4 in the Table). Three of the countries from the perverse split at zero are in this group, but the US, Japan and Italy no longer show perversity in this case. However, Australia and Spain now do. (We were unable to produce estimates for Germany because of the overwhelming effect of unification.) Only in the case of the UK was the coefficient for the negative segment significantly different from zero at the 5 % level and here the threshold value, at –0.53 %, was very much out of line with the rest of the sample. Most thresholds lay in the range 2.3 to 4.3 % and all cases the restriction that the two GDP coefficients be equal was rejected.

Harris and Silverstone (1999b) also encounter the problem of perversity but only a limited scale and their estimates are well determined. They find that Canada does not show asymmetry, New Zealand, the US and Germany show no adjustment when the error correction term is negative – and hence clear asymmetry – while Australia and Japan have larger effects for the negative segment, i.e. reverse asymmetry. They do not suffer from unexpected signs. Thus their more limited sample demonstrates asymmetry on a rather similar scale to our own but with somewhat different country characteristics. The differences may simply reflect that the asymmetric process investigated is not the same.

However, use of these aggregate models in some senses only provides a description of the stylised facts and not an explanation of why the asymmetry may be occurring. This becomes clearer at the disaggregated level. In discussing regional disaggregation of the Phillips curve we suggested that it was the tightest labour markets that contributed to inflation and hence that we needed to consider

[34] Switzerland was eliminated from our initial sample owing to data difficulties in the 1960s.

[35] Moosa (1997) also gets a low value for Japan.

[36] I.e. if GDP falls.

the spread of unemployment across markets and not just the level in order to understand the nature of the problem. In the case of the Okun curve Haltiwanger and Schuh (1999) demonstrate that it is necessary to understand the dynamics of the labour market at the plant level to get an appreciation of asymmetry.

They show that a further term should be added to our formulation of the Okun curve, used in Table 6, which reflects the degree of 'job reallocation'[37] both within and between sectors. For all of the five different measures they use there is a clearly significantly positive effect on unemployment from increased rates of job reallocation. However, Haltiwanger and Schuh (1999) go even further and estimate determinants of job reallocation. Here not surprisingly it is downturns in the overall economy that help, including the lagged influence of monetary policy. Relative price shocks also provide an explanation so supply as well as demand shocks have a role to play. The problem also shows considerable persistence. Thus in downturns unemployment is more than symmetrically large than in upturns and takes longer to fall than it did to rise.

Taking the Phillips curve, Okun curve and IS curve results together gives us a somewhat better insight into the nature and causes of both asymmetry and nonlinearity in macroeconomic behaviour. Although, of course, some of the picture is clearly still omitted. It is clear that the variations across regions in labour markets and across sectors in product markets lead to important deviations in aggregate behaviour. When combined with the different national and sectoral responses to monetary policy, whether through the exchange rate or interest rates, this permits substantial departures from linearity. The asymmetries in the Phillips that we have explored appear to be primarily cyclical in character. The asymmetries in the Okun curve, on the other hand, are more complex, reflecting not just cyclical factors but the degree of sectoral and regional mismatch in the operation of the labour market. There is thus not just a nonlinear underlying relationship but asymmetric departures from it. As the average level of unemployment falls so the scope for regional and sectoral disparities also falls, as there is a lower bound. It seems likely therefore that there is more than one source of asymmetry. The structural mismatch in the labour market appears to be an additional cause to the traditional Phillips *curve* result.

The asymmetries are likely to interact. The asymmetric nominal rigidities implicit in the Phillips curve are likely to contribute to the asymmetric labour demand effects revealed in the Okun curve. Downward rigidities in prices and wages would tend to increase the variance of unemployment. The different sectoral responses to monetary policy will be a reflection of this. Asymmetric shocks will interact with the nonlinear responses and asymmetric processes themselves. When combined with the policy reaction this generates a considerable identification problem (as explained by Blinder and Solow (1973) in the case of fiscal policy and Haldane and Quah (1999) for monetary policy.)

In their tests of causes of asymmetry in the Phillips curve Dupasquier and Ricketts (1998) are able to isolate some evidence for the hypotheses of costly adjustment, capacity constraints and misperception (of aggregate and relative price shocks). The nominal wage resistance hypothesis was not obviously sustained, a result consistent with Yates (1998). Although to some extent these causes should be separable the results from their joint inclusion were not well determined. Eliasson's (1999) finding that the Phillips curve, using

[37] We describe this as 'churning' in Mayes (1996).

unemployment not an output gap as the determining variable, shows different sources of nonlinearity in Sweden and Australia is also helpful. In the Swedish case it is the rate of change of inflation expectations that is important, while for Australia it is the rate of change of unemployment.[38] The former case will have particularly important implications for the conduct of monetary policy. Moreover the fact that the sources of nonlinearity differ for these two countries and are not found in the case of the US emphasises the potential problem of aggregation that we have outlined for the euro area.

6 Conclusion

We have argued that there are clear asymmetries in the relationship between demand pressure, inflation and employment in the European union and the euro area in particular. These asymmetries exist at the sectoral and regional levels as well. As a result, if one were simply to use arithmetic weights to add effects across countries in order to determine area wide monetary policy this could produce erroneous results. This is exacerbated by the fact that there is considerable variation across the EU countries in their responses. It therefore matters which part of the area is experiencing which shocks. Average values can be misleading. However, if business cycles among the EU countries are becoming relatively co-ordinated, as Artis *et al.* (1999) indicate, then the problem is reduced.[39] It will then be differences in the speed an extent of the transmission mechanism within countries that matter rather than differences according to where they are in the cycle as well. It still will not disappear if the main problems lie in countries such as Spain where, according to our results, the impact of disinflationary policy is slower and milder than in many other countries.

Much of the literature on asymmetry in EMU is misconceived for our purposes as it focuses on the idea that individual countries will vote for the policy that would be best suited to their own needs and that the compromise or majority position may be suboptimal.[40] Our implicit assumption is that all those deciding on monetary policy are trying to so from the point of view of what is best for the euro area as a whole.[41] Our concern is simply that if constant arithmetic weights are used in a nonlinear and asymmetric world there is a danger of generating inefficient outcomes.[42]

We primarily focus on asymmetries stemming from the behaviour of the labour market. Rapid downturns in the economy appear to have more than proportionate downward effects on unemployment, partly because of mismatch between the sectors and regions where the jobs and unemployed lie. *This effect is*

[38] Buxton and Mayes (1986) also made this finding for the importance of the rate of change of unemployment in the case of the UK.

[39] However, Artis *et al.* (1999) also finds discrepancies in behaviour between recoveries and recessions. For example, Spain has a weak and slow response to recessionary forces compared to its partners but a stronger one than the average with respect to booms.

[40] Alesina and Grilli (1992) were among the first to discuss how policy might actually be decided and a substantial literature has developed along these lines.

[41] We therefore do not have to face any problems about whether policy is based on the median voter or the nature of qualified or other majorities.

[42] Tarkka (1997) has already shown that insisting on consensus decions could make the result even worse.

likely to be greater in the EU where labour mobility is lower than in the US where the phenomenon is already clear. A slower response to adverse shocks makes recovery phases longer and unemployment persistent.

However, these forms of asymmetry have a rather different impact on the inflationary process. The straightforward asymmetry, inherent in the convexity of the Phillips curve, is that excess demand in product or labour markets has a significant upward effect on inflation while deficient demand has little or no effect on lowering inflation. The process is however more complex as the dynamics suggest that big differences between sectors and regions distort the picture. It is the existence of tightness in parts of the labour market that affects overall inflation and average unemployment and by analogy probably tightness in sectors of the product market that tends to intensify the inflationary pressure. Thus our findings indicate that in each example we have considered, ignoring the disaggregated problem will tend to result in misleading policy conclusions.

The asymmetry is not restricted to demand shocks, as supply shocks, particularly through the exchange rate and foreign sector, can have sharply differing impacts both across the member states of the EU and across the sectors of industry. The traditional implication for policy set out in Laxton *et al.* (1995) is that monetary policy will need to be set somewhat more restrictively than is implied by linear symmetric models. However, it is also likely that any 'new economy' effects, where faster non-inflationary and higher unemployment growth develops, may occur in the areas of high demand and relative labour shortage (Oliner and Sichel, 2000). Hence the implications of the asymmetric effects, observed in data from the past may need to be rethought if major sectors in the economy are undergoing structural change in their responsiveness and flexibility.

None of this argument implies that running a single monetary policy is inappropriate. However it does have two other major implications. First, it implies that in setting monetary policy the ECB needs to take account of the problems of asymmetry and aggregation. Second, it entails that the governments of the member states both individually and jointly need to consider what other policy changes are needed in order offset the blunt nature of the impact of monetary policy. Structural and fiscal policies can be far better tuned to have detailed impacts on parts of the economy. This second message is not new and is not the focus of this paper. Our concern is to highlight the first implication, that for the setting of ECB monetary policy.

However, it would be mistaken to assume that the effects will be wholly negative in terms of reducing the bite of monetary policy at low levels of inflation or negative output gaps. Much of the point of EMU is to change macroeconomic behaviour for the better in the member states. The more rapidly developing economies will be facing looser monetary policy than would have been the case without the union (except for countries that were closely targeting the DM, where there will be rather less change).[43] We can expect, for example, that the countries with the positive output gaps will in fact try to hold down prices more than they would previously out of fear that their competitive position would worsen now that they have no independent exchange rate to offset the worsening in inflation. Indeed there are signs in both Finland and Ireland, which have been growing

[43] Although Germany is the largest economy in the euro area and several other economies are closely integrated with it euro monetary policy will itself deviate from what the Bundesbank would have done as the Bundesbank would not have taken into account the consequences for the rest of the area.

rather faster than the rest of the euro area that recent growth-inflation combinations have become more favourable. In other words that the sustainable rate of growth has increased and that calculations of the output gap need to be revised (downwards).

It is, however, problematic to infer from this evidence that the response of the authorities to these observed asymmetries should itself be asymmetric in order to compensate. Past policy is part of the adjustment process and hence its results are incorporated in the estimated relations, especially those of a strongly reduced form nature. Asymmetries in policy may themselves have contributed to the observed asymmetries over the course of the cycle. Haldane and Quah (1999) note that the aggressive policy response to inflation in recent years may make the short-run Phillips curve look near horizontal. The obvious way to sort out the role of a nonlinear policy rule would be to specify the full four equation (nonlinear) model, which also includes the policy reaction function. This would be particularly difficult in our cross-country setting and will have to remain for future research. In any event the current fashion for policies aiming at reducing structural rigidities and improving market flexibility may itself tend to make the economy more symmetric and perhaps more linear in its behaviour.

Table 1. **The range of differences across the EU Countries (percentages)**

	Inflation 1999 (2000Q1)	GDP growth 1999 (2000Q1)	Share of manfs (agric/construc) 1997*	Share of exports in GDP 1998	Labour share 1997**
Maximum	2.5	8.3	0.253	0.844	0.526
	(4.7)	(11.0)	(0.051/0.106)		
Minimum	0.6	1.4	0.178	0.239	0.413
	(1.6)	(1.5)	(0.011/0.069)		

* Construction includes mining, electricity, gas and water.
** Compensation of employees/GDP

Table 2. **The IS curves: OLS estimation results for the 1987:1–1997:4 period**

Name lags	∇y_{t-1}	∇y_{t-2}	rr_{t-k}	re_{t-k}	$OECD_{t-k}$	R^2 (SEE)	DW	λ
Austria	.729	–.095	–.021	.009	.338	.660	1.90	2.4
2,2,2	(6.39)	(0.74)	(0.91)	(0.65)	(0.65)	(0.58)		
Belgium	1.145	–.457	–.046	.001	.334	.882	1.81	41.7
4,3,2	(6.60)	(2.85)	(1.28)	(0.08)	(1.55)	(0.40)		
Denmark	.105		–.152	.018	.065	.261	1.96	8.3
1,3,1	(1.02)		(1.77)	(1.51)	(1.12)	(0.84)		
Finland	.773	–.158	–.152	.048	.406	.881	1.99	3.1
3,2,2	(5.36)	(1.00)	(2.36)	(3.90)	(0.83)	(1.19)		
France	.960	–.274	–.069	.027	.305	.871	1.94	2.5
4,2,2	(6.64)	(1.56)	(2.06)	(1.99)	(1.35)	(0.44)		
Germany	.545	.181	–.072	.020	.123	.911	1.53	3.6
7,3,2	(2.73)	(1.23)	(0.87)	(0.84)	(0.57)	(0.81)		
Ireland	.970	–.298	–.056	.028	.788	.867	1.81	2.0
1,3,2	(7.18)	(2.63)	(1.73)	(1.56)	(3.09)	(0.72)		
Italy	.701		–.095	.012	.332	.767	1.97	7.8
3,2,1	(8.88)		(1.90)	(1.43)	(2.35)	(0.50)		
Neths	1.077	–.381	–.037	.016	.259	.824	1.86	2.3
1,2,2	(11.41)	(4.72)	(1.53)	(1.76)	(2.34)	(0.39)		
Port	.447	.135	–.081	.007	.747	.901	1.95	11.6
3,1,1	(3.47)	(1.30)	(2.87)	(1.24)	(3.74)	(0.48)		
Spain	1.518	–.595	–.008	.009	.115	.982	1.44	0.8
1,2,1	(15.98)	(6.53)	(1.16)	(3.01)	(1.85)	(0.18)		
Sweden	.537	.226	–.065	.052	.604	.809	2.33	1.2
1,2,2	(5.21)	(1.70)	(5.21)	(4.05)	(2.30)	(0.77)		
UK	.981	–.175	–.033	.022	.262	.950	1.83	1.5
1,1,1	(10.50)	(1.86)	(1.84)	(2.96)	(4.34)	(0.40)		

The dependent variable ∇y is the output gap constructed by the HP filter. rr is the real interest rate, re the real exchange rate with respect to US dollar. OECD denotes the output gap for OECD GDP. λ is the ratio between interest rate and exchange rate elasticities. Lags indicate the lag length for rr, re, OECD (in this order), respectively. The data are quarterly and cover the period 1987:1–1997:4. For the UK, the US output gap is used instead of the OECD output gap. The German equation includes a level and one period dummies for the unification period (1991:1–1997:4). All estimates are OLS estimates.

Table 3. **Estimates of an IS curve with panel data**

	∇y_{-1}	re_{-2}	rr_{-2}	$OECD_{-1}$	R2/SEE/DW	λ
EMU10	.833	.012	–.039	.334	.781/.699/2.06	3.3
	(26.76)	(3.47)	(2.43)	(4.36)		
EU11	.823	.014	–.037	.250	.759/.727/2.17	2.6
	(25.98)	(4.04)	(3.14)	(3.29)		
EU13	.812	.012	–.039	.301	.760/.721/2.04	3.3
	(29.37)	(3.85)	(3.58)	(4.45)		
EU13:GLS	.838	.012	–.023	.273	.803/.718/2.08	1.9
	(40.57)	(4.81)	(2.18)	(5.04)		
EU13:SUR	.812	.011	–.012	.265	.757/.725/2.02	1.1
	(35.70)	(4.28)	(1.34)	(4.28)		
Agriculture	.347	.010	–.010	.649	.152/4.532/1.77	1.0
	(3.90)	(0.42)	(0.13)	(1.32)		
Industry	.701	.026	–.056	.643	.658/1.444/2.17	2.2
	(19.08)	(3.78)	(2.25)	(4.37)		
Construction	.671	.005	–.089	1.017	.525/2.785/2.35	18
	(11.55)	(0.40)	(1.52)	(3.39)		
Services	.828	.006	–.028	.191	.703/.670/2.25	4.7
	(24.80)	(1.80)	(1.66)	(2.69)		

All estimates (except for EU 13 countries) are LS estimates. The dependent variable is ∇y_t, all variables are defined as in Table 2. The pooled cross-country data consist of observations for 1987.1–1997.4. GLS denotes Generalised Least Squares estimates, which use cross section weights to account for (cross-section) heteroscedasticity. SUR denotes Seemingly Unrelated Regression estimates. The standard errors are heteroscedasticity consistent. The number of observations is 442 for EMU 10, 484 for EU 11 and 576 for EU 13. With sectoral data, the number of observations is 483. The set of countries in this case is: Austria, Denmark, Finland, France, Germany, Italy, Netherlands, Portugal, Spain, Sweden and United Kingdom. Numbers inside parentheses are t-ratios except the Standard Errors of Regression.

Table 4. **Estimates of a nonlinear Phillips curve**

	Δp_{-1}	Δp_{-2}	Δm	Δm_{-1}	∇y^{-}	∇y^{+}	R2/SEE/DW $F(y^{-}=y^{+})$
SUR	.353	.377	.070	.024	.038	.038	.663/.692/2.02
	(14.25)	(16.21)	(10.86)	(3.70)	(3.90)	(3.90)	Constrained=
OLS	.304	.405	.076	.036	.019	.068	.667/.690/1.97
H=0	(8.98)	(12.52)	(7.32)	(3.67)	(0.79)	(2.71)	.230
GLS	.375	.397	.072	.020	.007	.066	.662/.694/2.08
H=0	(11.81)	(13.58)	(10.77)	(3.26)	(0.44)	(3.45)	.044
SUR	.350	.376	.070	.025	–.002	.076	.664/.692/2.03
H=0	(14.12)	(16.18)	(10.86)	(3.76)	(0.11)	(3.98)	.012
SUR	.350	.375	.070	.025	–.001	.075	.664/.692/2.03
H=–.005	(14.12)	(16.16)	(10.88)	(3.75)	(0.05)	(4.09)	.010
SUR*	.288	.259	.064	.017	.027	.090	.580/.336/2.00
H=0	(8.30)	(7.26)	(6.81)	(1.97)	(1.31)	(4.25)	.000
SUR*	.284	.274	.060	.016	.005	.020	.570/.543/1.93
H=0, a	(8.04)	(7.56)	(6.21)	(1.81)	(1.09)	(3.36)	.027
SUR*	.271	.261	.056	.014	–.005	.067	.576/.340/1.30
H=0, i	(6.66)	(5.70)	(5.71)	(1.59)	(0.38)	(4.30)	.002
SUR*	.293	.258	.060	.009	–.010	.031	.590/.332/1.93
H=0, c	(8.08)	(7.07)	(6.08)	(2.03)	(1.34)	(3.91)	.002
SUR*	.285	.269	.067	.018	.047	.077	.575/.539/1.98
H=0, s	(8.17)	(7.56)	(7.09)	(2.08)	(1.79)	(3.09)	.005
SUR*	.253	.264	.045	.055	–.001	.179	.639/.511/2.098
H=0	(5.66)	(6.14)	(3.54)	(4.40)			.147

The data cover the period 1975:4–1998:4. The number of observations is 1,176. p denotes consumer prices, m import prices and y the HP residual of GDR $F(y^{-} = y^{+})$ denotes probability of the F test statistics for the hypothesis that the coefficients of y^{-} and y^{+} are equal (in the first equation the coefficients are constrained equal). H shows the threshold value between ∇y^{-} and ∇y^{+}.

*The data cover the period 1987:1–1998:4 only. (a/i/c/s) The output gap for agriculture/ industry/construction/services is used for ∇y instead of the aggregate measure. The last rows correspond to a model in which the coefficients of the output gap are allowed to differ across countries. The reported values are the sums of these coefficients.

Table 5. **Estimates of the Phillips curve with regional EU data**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Δpe	.655	.649	.547	.513	.488		.522	.485
	(12.42)	(10.17)	(12.45)	(12.72)	(11.77)		(13.76)	(14.58)
Δp_{-1}	.254	.214	.277	.191	.143	.567	.187	.304
	(5.72)	(3.92)	(7.39)	(5.26)	(3.66)	(23.89)	(5.31)	(7.42)
Δm	.058	.056	.068	.063	.068	.085	.065	.053
	(6.56)	(5.43)	(10.23)	(10.14)	(9.25)	(13.19)	(10.54)	(7.42)
U	–.053	–.003	–.240	–.256	–.248	–.290	–.306/–.260	–.479/–.128
	(3.36)	(0.23)	(11.58)	(10.06)	(12.84)	(11.82)	(11.66/12.00)	(15.69)/(3.42)
Umax–Umin	.068		.110	.147		.154	.130	.041
	(4.81)		(5.97)	(6.47)		(6.86)	(5.91)	(2.39)
Usd		.103			.192			
		(2.32)			(2.93)			
t	–.016	–.001		–.112	–.108	–.112	–.110	
	(1.82)	(0.45)		(10.06)	(9.05)	(9.25)	(10.57)	
R2	.868	.866	.897	.914	.918	.885	.918	.871
SEE	.963	1.073	.884	.816	.878	.938	.797	.993
DW	1.526	1.289	1.726	1.800	1.590	1.928	1.822	1.452
Dummies	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Obs	153	143	153	153	143	153	153	153

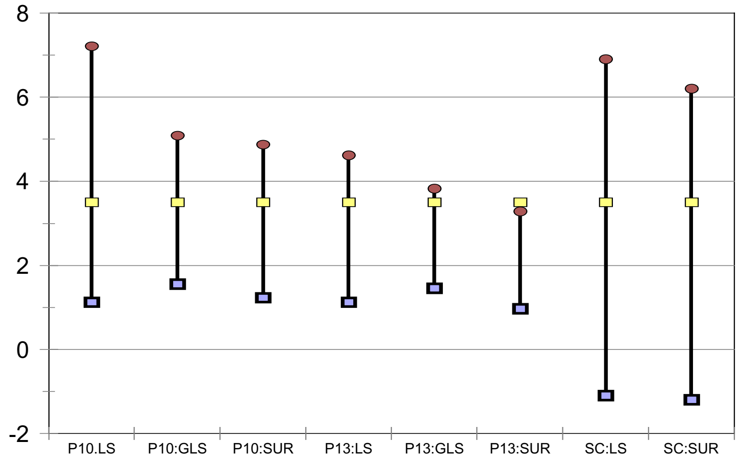
All estimates are SUR estimates. Δpe denotes expected inflation (OECD forecasts), m import prices, p consumption prices, U the aggregate unemployment rate, Umax–Umin the dispersion of regional unemployment rates, Usd the corresponding standard deviation and t time trend. Equation (7) is estimated using a threshold model specification and allowing the coefficient of the unemployment rate to vary depending on whether the rate is below (first coefficient) or above the 10.8 % (second coefficient) threshold. The hypothesis that the coefficients are equal can be rejected with marginal probability of 0.0013 % using the F test. Equation (8) is estimated similarly but now using the deviations of the unemployment rate from the "equilibrium" level as the explanatory variable (instead of U). The corresponding equilibrium level was constructed by the Hodrick-Prescott filter. In this case, zero threshold was used. Now the F-test statistic was much higher (with marginal probability of 0.000).

Table 6. **Estimates of a nonlinear Okun curve**

	$y^+(0)$	$y^-(0)$	$y^+(c)$	$y^-(c)$	F
Australia	–.021	–.049	–.045	–.002	10.26
	(4.04)	(0.41)	(3.42)	(0.09)	
Austria	–.039	–.512	–.050	–.075	14.53
	(3.76)	(0.47)	(5.03)	(3.93)	
Belgium	–.026	–.125	–.038	–.070	18.29
	(2.33)	(2.85)	(4.42)	(4.66)	
Canada	–.038	–.068	–.040	–.071	15.23
	(4.22)	(2.62)	(5.78)	(4.93)	
Denmark	–.022	–.451	–.030	–.392	18.45
	(1.03)	(3.36)	(1.48)	(3.52)	
Finland	–.071	–.070	–.066	–.079	16.82
	(5.29)	(3.07)	(6.15)	(6.28)	
France	–.019	–.050	–.028	–.080	15.75
	(1.15)	(0.43)	(2.00)	(2.48)	
Germany	–.096	–.135	–	–	–
	(4.56)	(0.93)			
Greece	–.023	.024	–.027	.038	21.67
	(3.03)	(0.67)	(3.58)	(1.19)	
Iceland	–.072	–.119	–.076	–.121	15.67
	(4.84)	(2.81)	(5.76)	(3.35)	
Ireland	–.019	–.088	–.025	–.050	5.20
	(2.17)	(0.35)	(3.31)	(2.86)	
Italy	–.026	.021	–.019	–.043	14.05
	(2.27)	(0.34)	(1.81)	(2.82)	
Japan	–.007	.013	–.008	–.020	10.33
	(1.16)	(0.18)	(1.35)	(2.02)	
Netherlands	–.023	–.182	–.048	–.123	112.86
	(0.95)	(1.22)	(2.73)	(4.07)	
New Zealand	–.075	–.036	–.086	.025	24.38
	(1.21)	(0.22)	(1.78)	(0.33)	
Norway	–.043	–.185	–.059	–.094	6.79
	(2.14)	(0.49)	(3.00)	(2.95)	
Portugal	–.044	–.250	–.055	–.094	16.11
	(2.47)	(0.71)	(3.19)	(3.60)	
Spain	–.019	–.062	–.026	–.013	29.24
	(3.49)	(0.79)	(5.09)	(1.61)	
Sweden	–.064	–.122	–.062	–.110	13.11
	(2.72)	(1.92)	(3.65)	(5.05)	
UK	–.032	.095	–.031	.102	21.08
	(1.50)	(1.83)	(1.51)	(1.97)	
USA	–.067	–.036	–.061	–.081	9.39
	(7.39)	(0.98)	(9.57)	(5.24)	

Numbers in parentheses are t-ratios. $y^+(0)$ and $y^-(0)$ denote estimates with zero threshold and $y^+(c)$ and $y^-(c)$ estimates with nonzero (estimated) threshold value. The parameters are derived from the following estimating equation $\Delta u_t = a_0 + a_1\Delta y^+_t + a_2\Delta y^-_t + a_3\Delta pop_t + a_4\varepsilon_{t-1} + e_t$, where u denotes the (log) number of unemployed, y the growth rate of output, pop the (log) working-age population, ε an error-correction term in terms of u, pop and time trend and e the error term. In the nonlinear case, y is replaced by y^+ and y^- so that y^+ corresponds to positive values of y and y^- of negative values. F is the F(1,31) test for the equality of the coefficients of y^+ and y^- in the case of nonzero threshold. Estimates are based on annual OECD data for 1961–1997.

Figure 1. **Confidence intervals of MCI weights**



P10 = EMU, P13 = EU, SC = single countries, LS = least squares, GLS = generalised least squares, SUR = seemingly unrelated regression estimates

Figure 2. **Values of MCI parameter for different sectors**

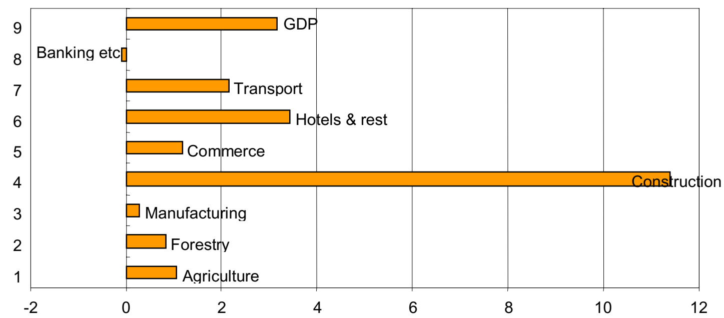


Figure 3. **Sectoral and panel estimates of MCI ratios for the EU**

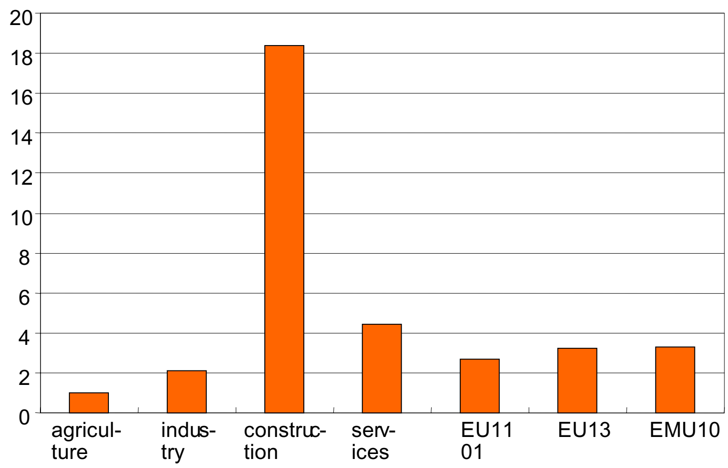


Figure 4. **Estimates of simple nonlinear Phillips curve for the EU**

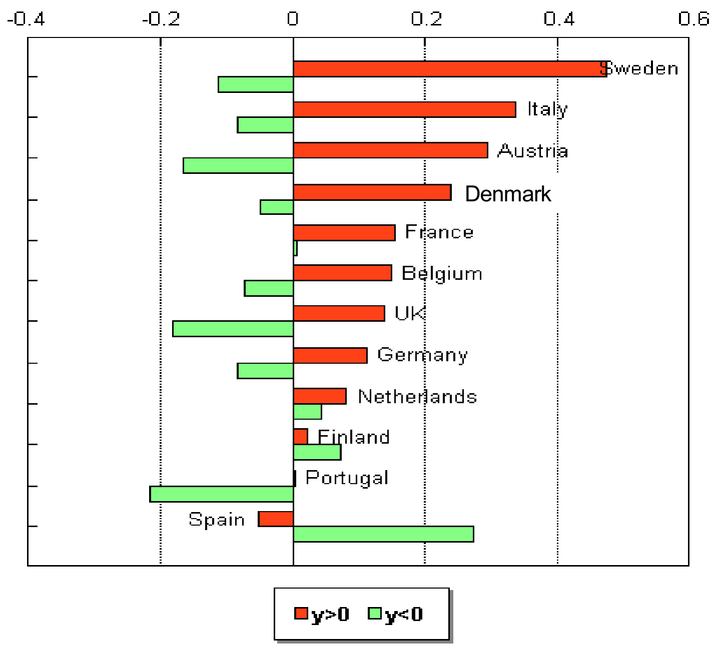


Figure 5. **Linearity and nonlinearity in the Phillips curve and the setting of policy**

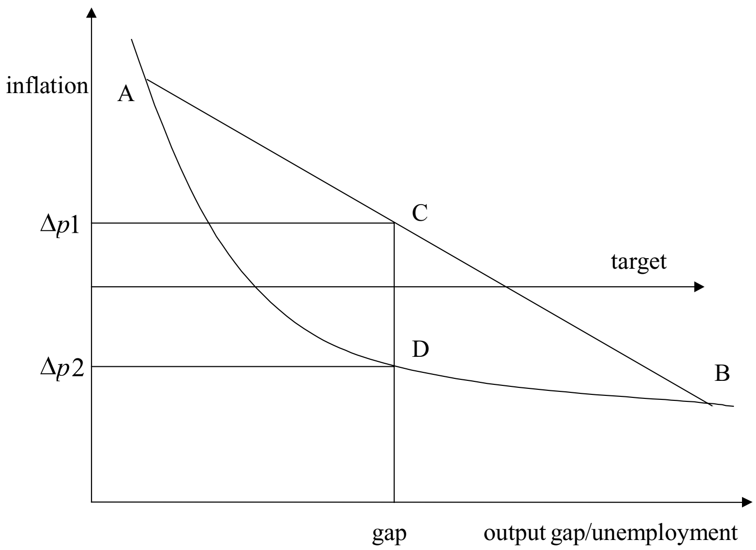
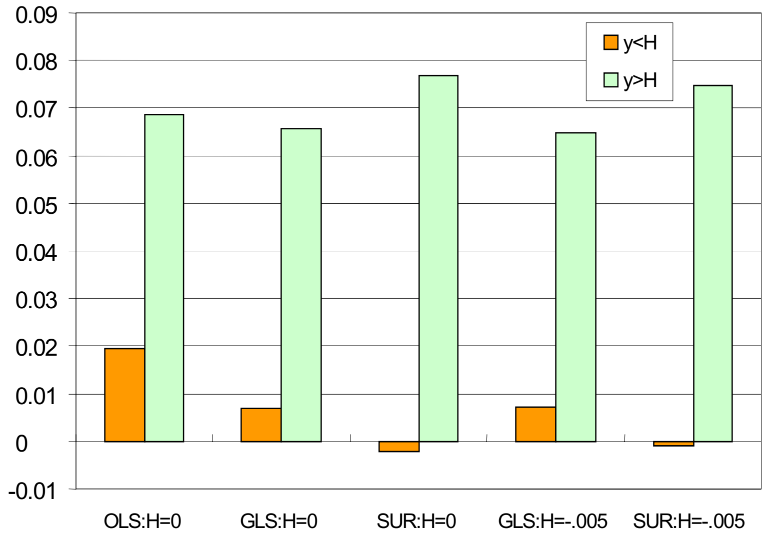
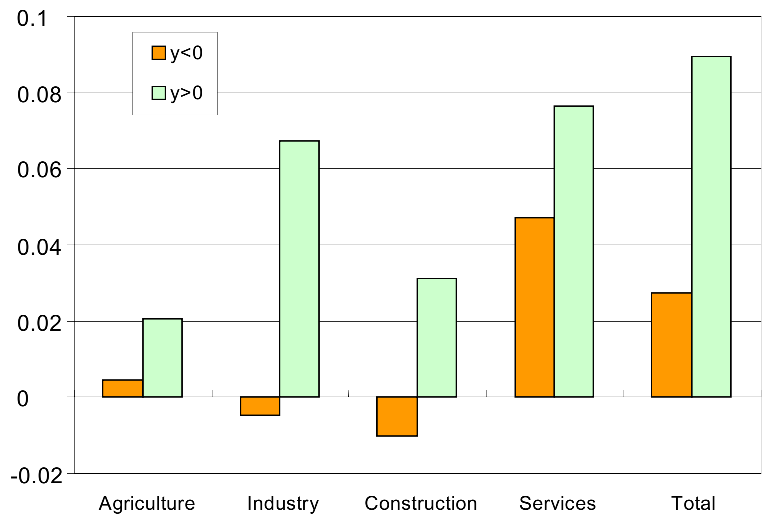


Figure 6. **Output gap coefficients in piecewise linear Phillips curve for the EU**



Panel data as in Table 3. OLS, GLS and SUR defined as in Figure 1. H denotes level of output gap at which the split takes place.

Figure 7. **Output gap coefficients from the piecewise linear Phillips curve using sectoral data**



Notes as for Fig 6.

References

Aigner, D. – Lovell, C.A.K. – Schmidt, P. (1977) **Formulation and Estimation of Stochastic Frontier Production Functions.** Journal of Econometrics, vol. 6, 21–37.

Alesina, A. – Grilli, V. (1992) **The European Central Bank: Reshaping Monetary Politics in Europe.** In (M. Canzoneri – V. Grilli – P. Masson, eds.) Establishing a Central Bank: Issues in Europe and Lessons from the US, Cambridge: Cambridge University Press.

Artis, M. – Krolzig, H-M. – Toro, J. (1999) **The European Business Cycle.** European University Institute Working Paper 99/24.

Attfield, C. – Silverstone, B. (1998) **Okun's Law, Cointegration and Gap Variables.** Journal of Macroeconomics, vol. 20, 125–137.

Baldwin, R. – Krugman, P. (1989) **Persistent Trade Effects of Large Exchange Rate Shocks.** Quarterly Journal of Economics, vol. 104 (4), 635–645.

Ball, L. (1993) **What Determines the Sacrifice Ratio.** NBER Working Paper 4306.

Ball, L. – Mankiw, N.G. (1995) **Relative Price Changes as Aggregate Supply Shocks.** Quarterly Journal of Economics, vol. 110, 161–194.

Blinder, A.S. – Solow, R. (1973) **Does Fiscal Policy Matter?** Journal of Public Economics, vol. 2, 319–237.

Buxton, A. – Mayes, D.G. (1986) **The Persistence of Unemployment.** Quarterly Bulletin, no. 88 (December), 29–37.

Chetty, V. – Heckman, J. (1986) **A Dynamic Model of Aggregate Supply, Factor Demand and Entry and Exit for a Competitive Industry with Heterogeneous Plants.** Journal of Econometrics, vol. 64, 237–262.

Clark, P.B. – Laxton, D. (1997) **Phillips Curves, Phillips Lines and the Unemployment Costs of Overheating.** IMF (August).

Clark, P.B. – Laxton, D. – Rose, D. (1996) **Asymmetry in the US Output-Inflation Nexus: Issues and Evidence.** IMF Staff Papers, vol. 43, no. 1.

Davis, S.J. – Haltiwamger, J.C. – Schuh, S. (1996) **Job Creation and Destruction.** Cambridge MA: MIT Press.

Debelle, G. – Laxton, D. (1996) **Is the Phillips Curve Really a Curve? Some Evidence for Canada, the United Kingdom and the United States.** IMF Working Paper WP/96/111 (October).

Dornbusch, R. – Favero, C. – Giavazzi, F. (1998) **Immediate Challenges for the European Central Bank.** Economic Policy, no. 26, 17–52.

Duguay, P. (1994) **Empirical Evidence on the Strength of the Monetary Transmission Mechanism in Canada.** Journal of Monetary Economics, vol. 33, 39–61.

Dupasquier, C. – Lalonde, R. – St Amant, P. (1997) **Optimum Currency Areas as Applied to Canada and the United States.** In Bank of Canada Exchange Rates and Monetary Policy, Ottawa.

Dupasquier, C. – Ricketts, N. (1998) **Nonlinearities in the Output-Inflation Relationship: Some Empirical Results from Canada.** Bank of Canada Working Paper, 98–14.

Eichengreen, B. – Wyplosz, C. (1998) **The Stability Pact: More than a Minor Nuisance?** Economic Policy, no. 26, 67–104.

Eika, K.H. – Ericsson, N.R. – Nymoen, R. (1996) **Hazards in Implementing a Monetary Conditions Index.** Oxford Bulletin of Economics and Statistics, vol. 58 (4), 765–790.

Eliasson, A-C. (1999) **Is the Short-Run Phillips Curve Nonlinear? Empirical Evidence from Australia, Sweden and the United States.** Mimeo, Department of Economic Statistics, Stockholm School of Economics.

Friedman, M. (1993) **The "Plucking Model" of Business Fluctuations Revisited.** Economic Enquiry (April), 171–177.

Gali, J. – Gertler, M. (1999) **Inflation Dynamics: a Structural Econometric Analysis.** Journal of Monetary Economics, vol. 44, 115–157.

Gordon, R. (1997) **The Time Varying NAIRU and its Implications for Economic Policy.** Journal of Economic Perspectives, vol. 11 (winter), 11–32.

Granger, C.W.J. – Teräsvirta, T. (1993) **Modelling Nonlinear Economic Relationships.** Oxford: Oxford University Press.

Haldane, A. – Quah, D. (1999) **UK Phillips Curves and Monetary Policy.** Bank of England, October.

Haltiwanger, J.C. – Schuh, S. (1999) **Gross Job Flows between Plants and Industries.** New England Economic Review, (March/April), 41–64.

Hansen, B. (1999) **Testing for Linearity.** Journal of Economic Surveys, vol. 13, 551–576.

Harris, R. – Silverstone, B. (1999a) **Asymmetric Adjustment of Unemployment and Output in New Zealand: Rediscovering Okun's Law.** University of Waikato Working Paper 99/1.

Harris, R. – Silverstone, B. (1999b) **Asymmetric Adjustment of Unemployment and Output: Cross-country Estimates of Okun's Law.** University of Waikato Discussion Paper 99/2.

Hendry, D.F. (1995) **Dynamic Econometrics.** Oxford: Oxford University Press.

Kaufman, S. (1988) **Likelihood Based Inference in Cointegrated Vector Autoregressive Models.** Oxford: Oxford University Press.

Keynes, J.M. (1936) **The General Theory of Employment, Interest and Money.** London: MacMillan.

Kim, C-J. – Nelson C.R. (1999) **Friedman's Plucking Model of Business Fluctuations: Tests and Estimates of Permanent and Transitory Components.** Journal of Money Credit and Banking, vol. 31 (3), 317–334.

Kortelainen, M. (2000) **Actual and Perceived Monetary Policy Rules in a Dynamic General Equilibrium Model of the Euro Area.** Mimeo, Bank of Finland (July).

Koskela, E. – Virén, M. (1990) **Monetary Policy Reaction Functions and the Saving Investment Correlations: Some Cross-Country Evidence.** Bank of Finland Discussion Paper 11/90.

Laxton, D. – Meredith, G. – Rose, D. (1995) **Asymmetric Effects of Economic Activity on Inflation.** IMF Staff Papers, vol. 42, no. 2.

Laxton, D. – Rose, D. – Tambakis, D. (1997) **The US Phillips Curve: The Case for Asymmetry.** IMF (September).

Laxton, D. – Rose, D. – Tetlow, R. (1993) **Problems in Identifying Nonlinear Phillips Curves: Some Further Consequences of Mismeasuring Potential Output.** Bank of Canada Working Paper 93–96.

Lilien, D. (1982) **Sectoral Shifts and Cyclical Unemployment.** Journal of Political Economy, vol. 90(4), 777–793.

Lucas, R.E. (1972) **Expectations and the Neutrality of Money.** Journal of Economic Theory, vol. 4, 103–124.

Lucas, R.E. (1973) **Some International Evidence on Output-Inflation Tradeoffs.** American Economic Review, vol. 63, 326–334.

Mayes, D.G. (1986) **Change.** Occasional Paper NZ Institute of Economic Research

Mayes, D.G. (1996) **Sources of Productivity Growth.** Cambridge: Cambridge University Press.

Mayes, D.G. – Chapple, B.R. (1995) **The Costs and Benefits of Disinflation: A Critique of the Sacrifice Ratio.** Reserve Bank of New Zealand Bulletin, vol. 589(1), 9–21.

Mayes, D.G. – Harris, C. – Lansbury, M. (1994) **Inefficiency in Industry.** Hemel Hempstead: Harvester Wheatsheaf.

Mayes, D.G. – Silverstone, B. (1998) **Institutional Reform in a Labour Market: The Case of New Zealand.** Tinbergen Institute, May.

Mayes, D.G. – Virén, M. (1998) **The Exchange Rate and Monetary Conditions in the Euro Area.** Bank of Finland Discussion Paper 27/98.

Mayes, D.G. – Virén, M. (2000) **Exchange Rate Considerations in a Small Open Economy: A Critical Look at the MCI as a Possible Solution.** Forthcoming in Mahadeva, L. and Sterne, G. eds Monetary Policy Regimes London: Routledge.

McDonald, I.M. (1997) **The Australian Inflation Target and the Shape of the Short-Run Phillips Curve.** University of Melbourne, Mimeo.

Mishkin, F. (1995) **The Channels of Monetary Transmission: Lessons for Monetary Policy.** NBER Working Paper 5464.

Moosa, I.A. (1997) **A Cross Country Comparison of Okun's Coefficient.** Journal of Comparative Economics, vol. 24, 335–356.

Obstfeld, M. – Peri, G. (1998) **Asymmetric Shocks.** Economic Policy, no. 26, 207–247.

Okun, A. (1962) **Potential GDP: Its Measurement and Significance.** Proceedings of the Business and Economics Statistics Section of the American Statistical Association, 98–104.

Oliner, S.D. – Sichel, D.E. (2000) **The Resurgence of Growth in the Late 1990s: Is Information Technology the Story?** Mimeo, Board of Governors of the Federal Reserve System (February).

Orphanides, A. – Wilcox, D. (1996) **The Opportunistic Approach to Disinflation.** Board of Governors of the Federal Reserve System Discussion Paper 96–124.

Palley, T. (1993) **Okun's Law and the Asymmetric and Changing Cyclical Behaviour of the US Economy.** International Review of Applied Economics, vol. 7, 144–162.

Phelps, E. (1967) **Phillips Curves, Expectations of Inflation and Optimal Inflation over Time.** Economica NS, vol. 35, 254–281.

Phillips, A.W. (1958) **The Relationship between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1861–1957.** Economica NS, vol. 25, 283–299.

Prachowny, M. (1993) **Okun's Law: Theoretical Foundations and Revised Estimates.** Review of Economics and Statistics, vol. 75, 331–336.

Pyyhtiä, I. (1999) **The Nonlinearity of the Phillips Curve and European Monetary Policy.** Bank of Finland Discussion Paper 17/99.

Razzak, W. (1997) **The Inflation-Output Trade-off: Is the Phillips Curve Symmetric? A Policy Lesson from New Zealand.** Discussion Paper G97/2, Reserve Bank of New Zealand.

Stiglitz, J. (1984) **Price Rigidities and Market Structure.** American Economic Review, vol. 74, 350–355.

Stiglitz, J. (1997) **Reflections on the Natural Rate Hypothesis.** Journal of Economic Perspectives, vol. 11 (winter), 3–10.

Tarkka, J. (1997) **A Model of Common Monetary Policy.** Bank of Finland Discussion Paper 15/97.

Taylor, J.B. (1993) **Discretion versus Policy Rules in Practice.** Carnegie-Rochester Conference Series on Public Policy, vol. 39, 195–214.

Tong, H. (1983) **Threshold Models in Nonlinear Time Series Analysis.** (Lecture Notes in Statistics) New York: Springer Verlag.

Verbrugge, R. (1998) **A Cross-Country Investigation of Macroeconomic Asymmetries.** Mimeo, Department of Economics, Virginia Polytechnic Institute and State University.

Virén, M. (1993) **Interest Rates and Policy Reactions: Some International Evidence.** In (E.J. Stokking and G. Zambruno, eds) Recent Research in Financial Modelling, Heildelberg: Physica Verlag, 75–90.

Walsh, C. (1995) **Optimal Contracts for Central Bankers.** American Economic Review, vol. 85, 150–167.

Weber, C. (1995) **Cyclical Output, Cyclical Unemployment and Okun's Coefficient: A New Approach.** Journal of Applied Econometrics, vol. 10, 433–445.

Yates, A. (1998) **Downward Rigidity and Monetary Policy.** Bank of England Working Paper 114.

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