SUOMEN PANKKI · FINLANDS BANK

BANK OF FINLAND DISCUSSION PAPERS

9 • 2004

David G. Mayes – Matti Virén
Research Department
30.3.2004

Asymmetries in the Euro area economy

Suomen Pankin keskustelualoitteita
Finlands Banks diskussionsunderlag

Suomen Pankki
Bank of Finland
P.O.Box 160
FIN-00101 HELSINKI
Finland
☎ + 358 9 1831

http://www.bof.fi

BANK OF FINLAND
DISCUSSION PAPERS

9 • 2004

David G. Mayes – Matti Virén
Research Department
30.3.2004

Asymmetry in the Euro area economy

The views expressed are those of the authors and do not necessarily reflect the views of the Bank of Finland.

We are grateful for comments from colleagues and from seminar participants at the Austrian National Bank, the University of Auckland, The Federal Reserve Bank of Atlanta, the European Union Studies Association conference in Nashville, the Taipei International Conference on Modeling Monetary and Financial Sectors and the CEPR/ESI seventh annual conference on the Euro area as an Economic Entity at the Bundesbank Research Centre, Eltville. The views expressed here are personal.

Suomen Pankin keskustelualoitteita
Finlands Banks diskussionsunderlag

http://www.bof.fi

ISBN 952-462-130-4
ISSN 0785-3572
(print)

ISBN 952-462-131-2
ISSN 1456-6184
(online)

Multiprint Oy
Helsinki 2004

Asymmetries in the Euro area economy

Bank of Finland Discussion Papers 9/2004

David G. Mayes – Matti Virén
Research Department

Abstract

Using quarterly data for the period since 1987 this paper explores, in the context of a small model of the EU economy, the degree to which monetary policy has been asymmetric. It shows in particular that monetary policy has been much more responsive to threats that inflation would lie outside the price stability target than to equal sized shocks within the target zone. Similarly monetary policy has responded to threats of large positive and negative output gaps but has remained largely unresponsive to smaller divergences. It thus appears that the ECB and its predecessors have been avoiding 'fine-tuning' but have been aggressive in responding to substantial threats to macroeconomic stability. The action seems to have been stronger with respect to inflationary pressure than to deflation but this may offset any bias in fiscal policy. The asymmetric response of policy in part reflects considerable non-linearities and asymmetries in the behaviour of the euro area economies. High unemployment has relatively limited effect in pulling inflation down while low unemployment can be much more effective in driving it up. Economic downturns 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 IS curves across countries, sectors and regions. Monetary policy reacts in the light of this.

Key words: monetary policy, asymmetry

JEL classification numbers: E52, E61

Epäsymmetriat euroalueen taloudessa

Suomen Pankin keskustelualoitteita 9/2004

David G. Mayes – Matti Virén
Tutkimusosasto

Tiivistelmä

Tässä tutkimuksessa tarkastellaan rahapolitiikan epäsymmetrisyyttä tukeutuen analyyseissä pieneen EU-talouden malliin, joka on estimoitu vuoden 1987 jälkeiselle ajanjaksolle. Ilmenee, että rahapolitiikka on reagoinut voimakkaammin inflaatiouhkaan, joka on ollut hintavakaustavoiteregiimin ulkopuolella kuin samansuuruisiin inflaatiosokkeihin tavoiteregiimin sisällä. Samaten rahapolitiikka on reagoinut suurten positiivisten tai negatiivisten tuotantokuilujen uhkaan, mutta jäänyt verraten passiiviseksi pienten poikkeamien suhteen. Siten näyttää siltä, että EKP ja sen edeltäjät ovat välttäneet niin sanottua hienosäätöä, mutta olleet sen sijaan aggressiivisia reagoidessaan suuriin makrotaloudellisen tasapainon uhkiin. Toimet näyttävät olleen voimakkaampia inflaatiopaineisiin kuin deflaatiopaineisiin, mutta tämä saattaa vain korvata finanssipolitiikan mahdollisen erilaisen painotuksen. Epäsymmetrinen reagointi osaltaan heijastaa epälineaarisuuksia ja epäsymmetrioita euroalueen talouksissa. Suuri työttömyys vaikuttaa verraten vähän inflaation hillinnässä, kun taas vähäinen työttömyys selvästi kiihdyttää inflaatiota. Taloudelliset laskusuhdanteet näkyvät välittömämmin ja pysyvämmin työttömyyden kasvuna kuin noususuhdanteet työttömyyden vähentymisenä. Näitä ja IS-käyriin liittyviä riippuvuuksia on huomattavan suuri kirjo eri maissa, eri sektoreilla ja eri alueilla. Rahapolitiikan reaktiot selittyvät näiden erojen kautta.

Avainsanat: rahapolitiikka, epäsymmetria, Taylorin sääntö, epälineaarisuus

JEL-luokittelu: E52, E61

Contents

1 Introduction

All economies face problems of aggregation in running macroeconomic policy. If economic behaviour can be approximated reasonably by a linear representation then however diverse the economic structure, regional and industry performance, aggregation remains a second order issue. The consequences for each region or industry of single economy-wide policy, such as monetary policy, will however be drastically different if the economy is very diverse. This will pose problems for redistribution of income and wealth, migration, regional, industrial and other policies aimed at addressing the consequences for those differentially affected. If behaviour is both nonlinear and asymmetric, it becomes much more difficult to determine the appropriate single policy.

In most mature economies this potential problem is relatively little studied, in part perhaps because policymakers readily allow for it and partly because the offsetting redistributive measures are extensive and automatic. The problem is thus less visible ex post. In the euro area on the other hand there was little experience of running a single monetary policy before 1999, yet there was a great deal of information and experience at the member state level. The nature of the aggregation process has thus been much more obvious as has the diversity among the component economies.[1] Furthermore since there is little redistribution across national borders the divergent consequences are also more obvious. However, while the extent of the variation in behaviour is well known,[2] euro area policy simulations have typically been 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.[3] Such aggregations are usually either unweighted or based on GDP or similar weights.

In this paper we show that there are strong grounds for believing that there are considerable asymmetries and nonlinearities in inflationary behaviour and monetary transmission. Ignoring these could have substantial adverse effects on particular sectors, regions and member states within the euro area. In section 3 we develop a small conventional model of the monetary transmission mechanism in the euro area and show in section 4, using a dataset that covers all of the EU

---

[1] As an illustration of the variation across the member states of the euro area, inflation varied between 2.5 percent and 0.6 percent in 1999, GDP growth between 8.3 and 1.4 percent and the share of exports between 0.84 and 0.24.

[2] Dornbusch et al (1998), Eichengreen and Wyplosz (1998), Obstfeld and Peri (1998) for example.

[3] The Bank of Finland's EDGE model (Kortelainen, 2000) and ECB's AWM (Fagan et al, 2001) follow the first approach and the NIESR NiGEM, the European Commission's QUEST II, and the Netherlands Bank's EUROMON the second, for example.

countries except Greece and Luxembourg,[4] that there are good empirical grounds for asymmetry and/or nonlinearity in each of the relationships. In section 5 we show how these results pose problems for aggregation. Section 6 concludes but we begin, in section 2, by explaining how we use the term asymmetry and motivate the rest of the discussion.

2 The nature of asymmetry

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

In the European context the most common use of the word 'asymmetric' merely means 'different'. The simplest example comes in the concept of asymmetric shocks, which are just shocks that affect one part of the economy rather than another. Secondly, asymmetry is commonly used to refer to relationships where there are omitted variables or even omitted secondary equations. We show in Section 4 that there is one source of 'asymmetry' in this sense in the Okun curve. Namely that the dispersion of unemployment rates across the euro area affects the impact that the rate of economic growth has on unemployment rates. Similarly, Gaiotti and Generale (2001) and Loupias et al (2001) in showing that there is a credit channel for monetary policy describe this additional feature as 'asymmetry' in the monetary transmission mechanism.

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

$$x = a_0 + a_1 y + e \tag{2.1}$$

is not symmetric if $a_1 \neq a_2$ in

$$x = a_0 + a_1 y^+ + a_2 y^- + e \tag{2.2}$$

where $y^- = y$ when $y < y^T$ (= 0 elsewhere) and $y^+ = y$ when $y \geq y^T$ (= 0 elsewhere). y^T is a 'threshold' value (Granger and Teräsvirta, 1993; Tong, 1993).

[4] We thus cover not merely the current euro area but also the main countries that might join it over the coming few years. Data for Ireland are more limited and Greece and Luxembourg only excluded because data were not available.

A simple example would be the Phillips curve, where inflation responds differently depending upon whether the output gap is positive or negative. We can easily respecify x and y in first difference form (or first difference of logarithms) and show that for example the impact of changes in GDP on unemployment depend on whether the economy is growing or contracting.[5]

We have deliberately made this asymmetry very simple but one could argue that while the cointegrating relationship is symmetric the error correction mechanism could be asymmetric (Harris and Silverstone (1999) and Huang et al (2001)). Thus, if $\hat{a}_0$ and $\hat{a}_1$ are the estimated values of a_0 and a_1 and $\hat{e} = x - \hat{a}_0 - \hat{a}_1 y$ the computed error, then the error correction process will be asymmetric if $c_2 \neq c_3$ in

$$\Delta x = c_0 + c_1 \Delta y + c_2 \hat{e}^{+}_{-1} + c_3 \hat{e}^{-}_{-1} + \eta \tag{2.3}$$

where $\hat{e}^- = \hat{e}$ when $\hat{e} < \hat{e}^T$ and $\hat{e}^+ = \hat{e}$ when $\hat{e} \geq \hat{e}^T$ (= 0 elsewhere), $\hat{e}^T$ being the 'threshold' value.[6]

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

Much of the traditional treatment of asymmetry (Keynes, 1936; Diebold and Rudebusch, 1999) is concerned with the shape of the business cycle. Three characteristics of asymmetry in shape can be identified: *deepness* – do recessions tend to be deeper than booms are high (compared to some trend or sustainable growth path); *length* – do expansions tend to last longer than recessions and *steepness* – does the decline occur more rapidly than the recovery.[7] This asymmetry in outcome will tend to be a product of the asymmetries in relationships and shocks that we have identified.

---

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

[6] It is possible to specify the asymmetric adjustment process in terms of $\Delta\hat{e}$, as in Huang et al (2001), using the M-TAR model of Enders and Siklos (2001), rather than the TAR model in terms of $\hat{e}$, described in (2.3). M stands for momentum.

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

3 A simple model

In order to examine asymmetry we set up a simple and very conventional four equation model of the economy, consisting of an IS curve, a Phillips curve, and Okun curve and a monetary policy reaction function. Following Duguay (1994), Goodhart and Hofmann (2000), the IS curve is of the form

$$\nabla y_t = a_0 + a_1 \nabla y_{t-1} + a_2 \nabla y_{t-2} + a_3 rr_{t-i} + a_4 re_{t-j} + a_5 \nabla y^*_{t-k} \tag{3.1}$$

where ∇y is the deviation of output y from its Hodrick-Prescott filtered trend, rr is the real 3-month interest rate (ie the nominal rate of interest r less the annual rate of consumer price inflation Δp), re the real exchange rate with the US dollar (in logs) and ∇y^* the deviation of OECD output from its HP trend. (Lag lengths i, j and k typically vary from 1 to 3 quarters in estimation.) Equation (3.2) is a form of the expectations augmented Phillips curve

$$\Delta p = b_0 + b_1 \Delta p_{t-1} + b_2 \Delta p^e + b_3 \Delta p^* + b_4 u \tag{3.2}$$

p^e is expected inflation, p^* is the foreign price (in domestic currency) and u is the deviation of unemployment from its trend.[8] A simple form of the Okun curve is

$$\Delta U = c_0 + c_1 \Delta y + c_2 \Delta pop \tag{3.3}$$

where pop is the population of working age. Lastly we include a monetary reaction function in the form of a Taylor rule

$$r_t = \rho r_{t-1} + (1-\rho)[d_0 + d_1(\Delta p - \Delta p^T)_t + d_2 \nabla y_t] \tag{3.4}$$

where the parameter ρ permits an element of interest rate smoothing and Δp^T is the target for inflation (Huang et al 2001; Gerlach, 2000b).

This set of equations determines inflation, output, unemployment and the rate of interest. Foreign prices, foreign output and the exchange rate are treated as exogenous to the system. Data constraints lead us to modify (3.2) in some of the estimation and price expectations are represented by the OECD forecast a year ahead.

[8] We use a more complex lag structure in estimation.

4 Aggregation, nonlinearity and asymmetry in the Euro area

In the estimated version of (3.1) to (3.4) we use a panel of quarterly data for the period 1985.1 to 2001.3 for all the euro area countries except Greece and Luxembourg, for which the information was not available. This gives a potential 770 observations. The initial truncation date of 1985.1 is determined partly by availability of data but mainly because it is difficult to sustain the idea that there is a single regime applied over the period as a whole. Prior to 1985 there was considerable realignment of exchange rates within the ERM (Exchange Rate Mechanism) of the EMS (European Monetary System and in some cases we find we cannot use the first two years because the data are incomplete or show indications of a regime shift. We also find that there are substantial problems in handling the monetary policy reaction function (3.4) across the exchange rate crisis of 1992/3. The period since the beginning of 1999 lies within Stage 3 of EMU although in practical terms that can probably be dated earlier in 1998. As some of these problems lie within individual equations we therefore build up to the simultaneous estimation of the entire system of equations by considering the four components in turn. While the simultaneous model is deliberately kept simple we use some additional information in some of the individual equations to explore robustness and some of the variation among the individual countries.

4.1 The IS curve

The model set out in (3.1)–(3.4) above is linear until we apply the threshold decomposition explained in (2.1)–(2.3) to it. We begin, therefore, just with the problem of aggregation using the linear IS curve (3.1) before adding the complication of asymmetry. Parameter estimates (shown in Mayes and Virén (2000) Table 4) for the period 1987.1 to 1997.4 for the EU countries (excluding Greece and Luxembourg) vary considerably across the individual countries, both in terms of lag structures and the values of the coefficients. If we take just the impact of a 100 basis point interest rate increase, after allowing for the lag structures, the results vary from 0.5 to 3.8 percent of GDP with the bulk of the estimates falling in the range 1.0 to 2.2 percent. Thus, if the problem to be corrected by policy lay in low response countries in the EU, other, more responsive, member states would bear a greater proportion of the adjustment if there an equal change in the interest rate across the whole area.[9]

The same problem of variation in response applies to external influences, which are incorporated in the IS curve (3.1) through the real exchange rate with respect to the US dollar.[10] The member states react differently to the real exchange rate. The significance of this for monetary policy can be judged better by considering the ratio of the real interest rate and real exchange rate coefficients $\lambda = a_3/a_4$. These ratios range from around 2 to 8 if we ignore the outliers (Figure 1, last col.).[11] During 1999 and 2000 the euro depreciated by over 25 percent against the dollar. This would imply that the impact on the output gap ranged from the equivalent of 300 basis point fall in the real interest rate to around 1200 basis points. Using a weighted average (GDP weights) the ratio for the euro area in the previous period was around 3.5 (Mayes and Virén (1998) use a variety models to establish this value and not just equation (3.1) above). Policy aimed at the area as a whole would therefore respond to this average value or rather to its estimated value for 1999 and onwards as policy is forward-looking if the ratio were computed in this manner.

If we assume that the principal parameters in (3.1) are the same across the euro countries by treating the data as a panel, we can see (Table 1) that the results change and lower estimates for λ are obtained in each case, although not strikingly so. This implies that the exchange rate is even more important in the monetary transmission mechanism than we previously estimated. The results are little changed, although better determined (see the first two cols. in Figure 1), if

---

[9] The data period for estimation is prior to the operation of the ECB so using it to draw inferences about the operation of monetary policy under Stage 3 of EMU implies some strong assumptions about the invariance of behaviour. However, it would require implausibly large changes for the problem we illustrate to disappear rapidly.

[10] Other currencies, particularly sterling, play an important role in some countries, so focusing purely on the US dollar may be misleading. Indeed in more recent work (Mayes and Virén, forthcoming and Table 5, here) we have used the effective real exchange rate. First results suggest that the role of the exchange rate in that specification is much stronger than if we restrict it to the US dollar. In Mayes and Virén (1998) we also showed that in the case of Finland, where both sterling and the Swedish krona account for significant proportions of trade, using a trade-weighted index does alter the numerical value of the coefficient noticeably. However, the qualitative impact, which is the focus of our discussion here, was small. The Irish Republic is the only country where the dollar is clearly not the most important external currency. Similarly over this period, although most of the countries were participating in the Exchange Rate Mechanism of the European Monetary System, exchange rates with respect to each other also changed, particularly around 1992. We show that adding the DM exchange rate adds very little to the overall explanation but results in poorly determined coefficients and perverse effects in four cases.

[11] Each column in the figure shows our original estimate of 3.5 for λ for the euro area. The line then shows the 95 percent confidence interval for the estimates derived from the various versions of (3.1) described in the text.

we add the EU countries that are not currently members of the euro area (excluding Greece) to the sample (labelled EU13 in Row 5 of Table 1). However, when GLS or SUR estimation is applied the estimates become considerably smaller still, 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 over this time period would thus tend to generate inappropriate conclusions for policy and is clearly rejected by the data.[12] The simultaneous estimates for the whole system, Table 8, indicate that satisfactory estimates can be obtained for the period 1993–2001 using panel data for the EMU10 countries. Rows 2 and 3 of Table 1 indicate that extending this particular equation to the whole of our dataset (1985.1–2001.3) suggests a little more responsiveness to both interest and exchange rates but SUR estimates give a more plausible value for λ.

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. To give an indication of the importance of economic structure in the estimation of λ we disaggregated Finnish GDP into 8 main sectors, shown in Figure 2, and estimated sectoral λs of the same form. As might be expected it is the highly traded sectors where λ is lowest: manufacturing, forestry and agriculture; and the resident sectors such as construction and hospitality where λ is higher.[13] 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 λ 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 λ. 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 λ 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 λs would fall or rise.

The same pattern of industry differences emerges at the European level, as can be seen in Table 1 from the estimates of (3.1) at the sectoral level for

---

[12] Eika et al(1997) show that there are considerable difficulties in estimating λ from equations of the form of (3.1), which help explain why one can get implausible and poorly determined coefficients. This is one reason why we explore so many different routes to obtaining estimates of λ in Mayes and Virén (2000).

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

Agriculture, Industry, Construction and Services.[14] The estimated λs follow the same pattern as before in order of decreasing openness: agriculture 1.0, industry 2.2, services 4.7 and construction 18. 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 across industries. Or turning this argument round, the impact of a common shock will vary both by member state and by industry.

4.1.1 Asymmetry in the IS curve

Before proceeding to the estimates of our threshold model, it is worth noting two different but well used facets of the term 'asymmetry' in the context of the IS curve. The first we have already illustrated, namely, that the parameters vary across the member states. The second is that there will be systematic departures from the simple relationship set out in (3.1) that affect the deepness, steepness and length of the business cycle if important relevant variables have been omitted. We can show this very simply by augmenting the equation to include two further asset prices in addition to interest rates and the exchange rate, namely house prices, hp, and stock prices, sp:

$$\begin{aligned}\nabla y_t = \alpha_0 + \alpha_1 \nabla y_{t-1} + \alpha_2 rr_{t-2} + \alpha_3 re_{t-1} + \alpha_4 \nabla yoecd_{t-1} \\ + \alpha_5 \Delta hp_{t-1} + \alpha_6 \Delta sp_{t-1} + \varepsilon_t,\end{aligned} \quad (4.1)$$

where as before, ∇y = (log) output (GDP at constant market prices) gap, $\nabla yoecd$ is the OECD (log) output gap, rr = real interest rate (ie nominal 3 month rate minus annual inflation in the consumer price index, pc, %) and re = real effective exchange rate.[15] Here hp = log of house prices deflated by the consumer price index and sp = log of stock prices deflated by the consumer price index.

We can motivate this extension readily as one use of the ratio λ has been in constructing an index of monetary conditions (MCI). Such an index is thought to give an indication of the pressure on the economy from the financial prices most

---

[14] It was not possible to get disaggregated data for the period for Belgium or Ireland. Row 4 of Table 1 therefore shows the results for the remaining 11 (EU11) countries. The estimates are very similar to the other two aggregates of 10 or 13 countries.

[15] In Mayes and Virén (2002) we report results using just the real exchange rate with respect to the US dollar. While the sample period and countries included are slightly different the results are very similar for variables other than the exchange rate.

obviously affected by monetary policy, namely interest rates and the exchange rate. λ indicates the relative weight to be applied to the two components in the index. Other financial variables can be added to list, including long as well as short interest rates, stock prices and even house prices (Goodhart and Hofmann, 2000), if they can be shown to have a distinguishable impact on economic activity. In common with other authors (Mayes and Virén, 2002) we also initially included a long (10-year) real interest rate but it contributed little to the explanation. These more comprehensive indexes are labelled Financial Conditions Indexes (FCIs) (see Mayes and Virén (2002) for an explanation). These MCIs/FCIs are quite widely used by international organisations such as the OECD, IMF and European Commission and by financial analysts.

It is immediately apparent that adding house prices and stock prices affects the other coefficients and λ (Mayes and Virén, 2002). Some of the impact of interest rates appears to be taken up by the house price variable. In the more recent estimates shown in Table 2 using the effective exchange rate rather than just that with the US, the exchange rate tends to become less important. While house prices are clearly an important improvement to the overall specification, stock prices (although significant) add relatively little (in common with the findings of other authors, Goodhart and Hofmann (2000), Barata and Pacheco (2003), for example).[16] The UK probably provides the clearest example of the differing components of the FCI, so we illustrate that case in Figure 3. Although monetary policy has been quite active in recent years, the short-term real interest rate has fluctuated far less that either the exchange rate or stock and house prices. Adding in the real exchange rate shows a very different pattern for monetary conditions after 1992, with four years of relatively easy conditions followed by four years of relatively tight conditions until the easing in 2002. Adding in asset prices gives a considerably more volatile picture, despite the low weight on stock prices. During 2001 the FCI fell sharply because of the decline in stock market values whereas in 2002 the rise in house prices has begun to dominate them (Figure 3, second panel).[17] Changes in asset prices on this scale are bound to alter the shape of the economic cycle and indeed elicit responses from monetary policy.

---

[16] Research at the IMF (Ludwig and Sløk, 2002; Bayoumi and Edison, 2003) shows that the same pattern applies more widely across industrialised countries and, outside Japan, has been increasing rapidly in the 1990s as a result of upward valuations. The estimates shown in Table 2 allow for the possible endogeneity of house prices by joint estimation of house price equation of the form $\Delta hpt = \beta_0 + \beta_1 \Delta hp_{t-1} + \beta_2 rr_t + \beta_3 Y_t + \beta_4 \Delta pc_t + \varepsilon_t$ with the IS curve using SUR.

[17] Movements in house prices have varied strikingly across the euro area countries in recent years. While real house prices rose by around 10 percent a year in Greece, Spain and the Netherlands over 1998–2002 they fell in Germany (ECB, 2003). If we extend the period back to 1995, Irish house prices rose even faster at nearly 15 percent a year in nominal terms (BIS, 2003). Ranges in single years can be even wider, from 1.0 percent in Germany to 17.4 percent in Spain in 2002, for example.

Asset prices are particularly important (Cechetti et al (2000) for example) in the determination of monetary policy as they can introduce substantial nonlinearity into the cycle if bubbles develop. The cyclical dynamics through asset prices can be augmented by ill-tuned policy with debt deflation (King, 1994). The Nordic crises around 1990 illustrate these asymmetric dynamics graphically, especially in the case of Finland (Mayes et al (2001) inter alia). The sharp decline in the economy with a 12% fall in real GDP in just three years was in strong contrast to the sustained periods of growth that surrounded it.

The problem posed for monetary policy by these 'asymmetric' differences even in the linear IS curve is magnified when the rest of our model is added. Estimating the effect of any particular setting of monetary conditions on inflationary pressure in the euro area involves not just the IS curve but the link from the output gap through to inflation.[18] If the economic cycles of the Member States are not in phase then the individual output gaps will be relevant in assessing the likely bite of monetary policy. 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 disaggregated level and then aggregated.[19] 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, as we show in the next section.

4.2 The Phillips curve

While (3.1), although augmented, remains a linear relationship, (3.2), the Phillips curve (Phillips, 1958) is the archetypal nonlinear relationship in macroeconomics. 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 has frequently been estimated as a straight line.[20]

---

[18] It requires at least a 'Phillips curve' relating price inflation to the output gap. If the Phillips curve uses unemployment as the determining variable then an Okun curve is required as well to provide the link between output and (un)employment.

[19] 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 et al (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.

[20] The discussion of the Phillips curve remains contentious. Gordon (1997) maintains that it is 'resolutely linear' in the US while Stiglitz (1994) suggests that it could have the opposite curvature with firms being more reluctant to raise rather than lower prices. Yates (1998) offers a helpful classification of the main different factors that could lead to nonlinearity. Our concern here is mainly to test for the hypothesis of linearity rather than specify the exact form of the nonlinearity.

The form of the 'Phillips curve' that lends itself most readily to the application of our threshold model is the relationship between the output gap and price inflation (see Clark and Laxton (1997) for a brief review and alternative approach). Taking a backward-looking approach to expectations, allowing a slightly more complex lag structure and replacing unemployment with the output gap we can reformulate (3.2) and include the threshold in the form

$$\begin{aligned}\Delta p = b_0 + b_1\Delta p_{t-1} + b_2\Delta p_{t-2} + b_3\Delta m_{t-1} + b_4\Delta m_{t-2} + b_5\nabla y^{+} \\ + b_6\nabla y^{-} + \eta\end{aligned} \tag{4.2}$$

where ∇y^{+} denotes the values of the output gap that exceed a threshold value. Accordingly ∇y^{-} denotes the remaining values of ∇y.[21] Import prices, m, are used for the foreign price.

Figure 4 shows the results for b_5 and b_6 for the countries in our sample for the period 1985.1–2001.3 using a threshold of zero.[22] It is immediately clear from the first three columns of Table 3 that, with the exception of Spain and Finland, the results conform to the expected asymmetry 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.

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 an 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

[21] 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), Department of Treasury (1996) for instance). Corrado and Holly (2003) use a three facet curve for the UK and US but they have over double the number of observations. Alternatively we could smooth the once-and-for-all regime shift in the threshold model by using the so-called smooth transition regression model (STR) (Granger and Teräsvirta, 1993), also used by Eliasson (1999). The lack of sufficiently long time series also made this alternative less appealing. Introducing a quadratic (or indeed a cubic) term in the output gap would also be a straightforward way of incorporating nonlinearity.

[22] Estimation of specifications like (2.3) 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. 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. A grid search revealed that this value was only trivially different from the error minimising result.

asymmetric model the costs of pursuing a price level as opposed to an inflation target could be considerable. If 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 mis-estimation will be the other way round. The line will overestimate the importance of large negative output gaps and underestimate the importance of large positive gaps, possibly exponentially so, depending on the shape of the curve, as limits are likely to be approached in both dimensions.

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). Using the very simplified example shown in Fig 5 it is very obvious how ignoring asymmetry and aggregation problems could have an unfortunate effect for policy. 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 under estimated. 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. Thus it is

[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. Mayes and Virén (2000) also show examples of more explicitly curvilinear relations.

necessary to add not just results from different points on a nonlinear relationship but from different nonlinear relations. 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.[24]

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[25]
- the different countries have very different output gaps (their cycles are not well coordinated)
- the individual country relationships are very different from each other.

We explore these issues in more detail with the full model in Section 5.

Equation (3.2) expresses the Phillips curve in the more traditional form with unemployment rather than the output gap indicating the degree of demand pressure on inflation. While this specification provides a similar explanation of inflation the Wald tests shown in Table 3 indicate that there is little nonlinearity in the role of unemployment.[26] Nevertheless the two coefficients bear the expected relation to each other as in the normal Phillips curve. Unemployment that is above the Hodrik-Prescott trend has a weaker effect on inflation than unemployment when it is below it. We show in Table 8 for the complete model that this result depends somewhat on the exact data period chosen. Restricting the estimates to the period since the 1992 ERM crisis results in clearly different unemployment coefficients for the two regimes but with unemployment still having a weakly significant negative effect on inflation even when it is above trend. Yates (1998) also has problems with detecting a lower bound in the way we observed with the output gap.

---

[24] This is simplistic because the component economies interact, see Virén (2001) for example.

[25] De Grauwe and Sénégas (2003) show that even if the Phillips curves are linear then it will be more accurate if the monetary authority reacts by estimating national responses and aggregating rather than using simply the area-wide relationships – a result which is amplified in the presence of uncertainty. Uncertainty on its own is a reason for nonlinear policy responses (Meyer et al, 2001). Initial deviations from target could be tolerated on the grounds that they might represent changes in behaviour. Large deviations on the other hand would be obviously inconsistent, whatever behavioural changes might have occurred, and warrant a robust response.

[26] The signs are of course reversed in this case compared to the output gap. Fabiani and Morgan (2003) estimate Phillips curves with this format for the five largest euro area members, they consider aggregate and pooled estimates for the unemployment gap coefficient. While they find that the individual countries differ particularly in lag structures they do not explore asymmetry and hence their finding against aggregation bias does not include the problems we discuss in this paper.

4.2.1 The problem at the regional and sectoral level

The problem for aggregation from asymmetry and nonlinearity applies to some extent at whatever spatial level we choose to measure activity. Indeed regional data within countries will help show the extent of structural change and the degree of mismatch in behaviour across sectors and the economy. We therefore test the hypothesis that the greater the range/variance of regional 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.[27] The variance of unemployment acts as a measure of the mismatch across the EU. However, it has also been argued that it is the pool of suitably qualified unemployed in the areas of the main demand for labour that are most important in determining inflation. Those with less relevant qualifications or unable to take a job offer quickly will be less relevant, thus generating an asymmetric departure from the simple Phillips curve.

The effect of the range of regional unemployment on inflation may be even more extreme. For the case of the UK Buxton and Mayes (1986) showed that the region with the lowest unemployment (the South East) had a highly disproportionate impact on wage inflation for the country as a whole. 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.

The regional data available for the EU do not allow us simply to re-estimate the same formulation of the Phillips curve at a more detailed level. Most importantly the data are annual and relate to unemployment rather than the output gap. However, by using annual data it is no longer necessary to transform (3.2) and we can estimate it directly including a measure of forward-looking expectations

$$\Delta p = a_1 \Delta p^e + a_2 \Delta p_{t-1} + a_3 \Delta m + a_4 U + a_5 Udisp + a_6 t \qquad (4.3)$$

---

[27] This can be regarded as an extension to the Lilien index (Lilien, 1982; Mayes and Silverstone, 1998) $L = \sqrt{[\Sigma_i w_i (e_i - E)^2]}$, 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 successful in reducing unemployment elsewhere as the less rapidly growing regions are at creating unemployment.

The forward-looking estimate of Δp^e uses the forecasts that the OECD publishes annually for the year ahead.[28] Udisp, the variance of unemployment levels across each country has been included in two forms: the range, Umax-Umin, to capture any effect from the extremes, and the standard deviation, Usd.[29] The Eurostat Regio database at the NUTS3 level for the EU has some 251 regions for our subset of countries.[30] The data are annual for the years 1984–1998 but not all years are available for each country so we only obtain some 153 observations out of the potential 180.

We can see from Table 4 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.

In column 6 of Table 4 we try adding the asymmetry in the Phillips curve itself by replacing the single (linear) relationship with the two-piece threshold model. In this case the parameter (a_4) varies according to whether *unemployment* is above or below a threshold value. As there is no obvious *a priori* value for the threshold, we use Maximum Likelihood to estimate the threshold and the parameters of (4.3) jointly. This gives a value of 10.8% for the threshold, somewhat higher than the average value of unemployment of 8% for the estimation period. The difference in the two unemployment 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.[31]

---

[28] 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.

[29] 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 in the relationship is to be meaningful. We are grateful to a referee for suggesting we might include a measure of the third moment of unemployment to reflect asymmetry directly.

[30] The Irish Republic also had to be excluded through lack of data.

[31] We do not attempt to explain this threshold as some sort of NAIRU or natural rate, which is in any case normally thought to vary over time. We this avoid the debate in Karanassou et al (2003) about whether there is any such concept for a sample of European data that overlaps ours.

We can however follow up the issue of sectoral disaggregation of the Phillips curve by using the same sectoral data that we used for the IS curves in Table 1. We estimate (4.2) with the output gaps computed for each of the sectors individually rather than for the whole economy.[32] For all four sectors the impact on inflation is higher when there is a positive output gap (see the last four rows of Table 5). 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[33] 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.[34] Indeed they conclude (Laxton et al 1999, p. 1482) ‘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.

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

---

[32] Inflation also relates to the sectoral prices.

[33] Laxton, Rose and Tetlow (1993); Laxton, Meredith and Rose (1995); Clark, Laxton and Rose (1996); Debelle and Laxton (1997); Clark and Laxton (1997); Laxton, Rose and Timbakis (1999).

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

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.[35]

4.3 The Okun curve

The discussion of the Phillips curve dealt both with asymmetry from the labour market and asymmetry from excess demand. The Okun curve (3.3) in our model provides a link between output growth and unemployment and gives us a rather more satisfactory opportunity to distinguish the two sources of asymmetry. The Okun curve has been subject to quite extensive analysis in recent years[36] and Silverstone and Harris (1999) 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. Haltiwanger and Schuh (1999) introduce sector specific factors to help explain the lack of symmetry.

Following Laxton et al (1999) and Pyyhtiä (1999) we apply our threshold model to (3.3) in terms of output growth

$$\Delta U = c_0 + c_1 \Delta y^+(\tau) + c_2 \Delta y^-(\tau) + c_3 \Delta pop + c_4 \varepsilon_{-1} + \eta_t \qquad (4.4)$$

using an error correction format. Here Δy is the growth rate in GDP, pop the population of working age and ε the error correction term (lagged one period) and τ a threshold value for the asymmetry. Prachowny (1993) inter alia argues that some scaling of the labour variable in (3.3) is required so we include population of working age in our formulation.

As we noted in Section 2 there are two alternative ways of incorporating the asymmetry. The first, following Kim and Nelson (1999), using the Friedman (1993) 'plucking' model, 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

---

[35] The Phillips curve is also 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.

[36] Attfield and Silverstone, 1998; Harris and Silverstone, 1999; Kaufman, 1988; Moosa, 1997, Palley, 1993, Prachowny, 1993 and Weber, 1995, for example.

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.[37]

Our results, reported in Table 6, show estimates of (4.4) for the EEA countries from 1961 to 1997.[38] Only in the case of the UK do we find that there seems to be little relation between output and unemployment when using a linear formulation. 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[39], columns 1 and 2 in Table 6, in 12 of the 16 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 four cases that do not conform to this pattern, Finland shows no asymmetry, while Greece and Italy 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 three cases show coefficients where the effect on unemployment is smaller (less negative) below the threshold (columns 3 and 4 in the Table). Italy and Finland now follow the majority but Spain now shows perversity.[40] 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

---

[37] Thus in the case of (3.3) the error term η in the estimated version of (3.3) would be composed $\eta = v + e$, with $e \sim N(0, \sigma_e^2)$ and $v \sim M(\mu, \sigma_v^2)$ where M is a nonsymmetric distribution. Kim and Nelson (1999) assume that M is half Normal, Mayes et al (1994) also consider the more general case of a truncated normal.

[38] We have used both a longer data series and a wider range of countries than Harris and Silverstone (1999). While we did experiment with a split error correction term it appeared that incorporating the 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 split was already present. In part this may be due simply to the use of annual rather than quarterly data. For an application of the model to 21 OECD countries see Mayes and Virén (2000).

[39] Ie if GDP falls.

[40] We were unable to produce estimates for Germany because of the overwhelming effect of unification.

GDP coefficients be equal was rejected.[41] When we apply the model to our quarterly panel data (Table 7), using an HP trend to try to take account of the longer-run path in unemployment over the sample seems to be the least favourable to the nonlinearity hypothesis (columns 4–6), while using a constant (columns 1–3) gives the strongest support. The finding of nonlinearity is clearly dependent on model specification, variable transformation and the sample period chosen. As Table 8 illustrates for the full model, nonlinearity is present after 1992. While we have by no means explored every possibility there appears to be enough evidence to take the hypothesis of nonlinearity very seriously.

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 the spread of unemployment across markets and not just its 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, which reflects the degree of 'job reallocation'[42] 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.

One important explanation of asymmetry that we do not capture is the role of labour market institutions, particularly the trade unions. They may readily respond much more vigorously to the threat of job losses than they do to increases. The actions they can take are also somewhat asymmetric. There is no clear upside equivalent to withdrawing labour.

[41] Harris and Silverstone (1999) also encounter the problem of perversity but only on a limited scale and for a partly different group of countries. However their estimates are well determined.

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

4.4 Monetary policy

One of the difficulties about measuring the three foregoing 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 (Taylor, 1993). It is perhaps a little more realistic to consider the 'opportunistic' approach to policy (Orphanides and Wilcox, 2002) 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.[43] 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. However, here we experiment by introducing a policy reaction function directly into the model.

It is difficult to decide on a form for the monetary policy reaction function as the EU countries were following different regimes during the period. The Bundesbank used a form of enhanced money targeting (Issing et al, 2001), many of the other central banks were targeting the exchange rate within the ERM, while others including the UK, Sweden, Finland and Spain had periods of inflation targeting. However, as Collins and Siklos (2002) demonstrate, a simple Taylor Rule of the form of (3.4) where interest rate smoothing is included provides a reasonable representation of the behaviour of most modern regimes including the US, despite the fact that their ostensible objectives are different. It even embraces the 'speed limit' interpretation of US policy (Walsh, 2001, Woodford, 1999), although for some small open economies it might make sense to include the exchange rate. What is particularly interesting is that even though monetary policy is firmly forward-looking in the eyes of central banks including forecasts of inflation and the output gap in (3.4) do not alter the performance markedly. The position can change somewhat if the rule itself is forward-looking and targets

[43] 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*).

forecast inflation as in Svensson (1997), Schaling (2002) and Corrado and Holly (2003).

In view of the high level of endogeneity we only estimated the reaction function as part of the whole system (see the last three rows of coefficients in Table 8). It is immediately apparent that the results are dependent on the data period chosen. The problem lies with the breakdown of the ERM in 1992. If estimation is restricted to the post 1992 period (columns 5 and 6) then we observe the expected result. The weight on inflation is about twice that on the output gap and there is a large element of smoothing in policy. If 1992 is included in the data period then the weights are equal.

However, these results involve a symmetric reaction function. It is clear from Table 9 that the reaction function is itself asymmetric. The authorities appear to have responded more vigorously when inflation has been above 2 percent a year than when it is below it.[44] This asymmetry also seems to apply to the output gap. The interest rate response has been clearly stronger when output has been above trend than when it was below it.

We wondered whether this asymmetry was in fact somewhat misleading as the Eurosystem's target for price stability is for inflation not exceeding 2 percent over the medium term. Thus, if this were followed we would expect to see disproportionate reactions to *in*flation above 2 percent and to *de*flation. Rather than impose our own view of where the different regimes should lie we searched for the maximum likelihood estimates for rounded intervals. Here it appears that deflation is tackled even more vigorously than inflation above the target range (Table 10). The lowest weight is for inflation in the range zero to 4 percent a year. This somewhat wider range for milder action than that implied by the Eurosystem target is probably accounted for by the fact that most of the data period is before the ECB was set up. A similar set of results is obtained for the output gap, with larger coefficients outside a corridor 2 percent either side of zero. However, it was not possible to obtain significant coefficients for the output gap above the corridor. Indeed trying to include the output gap poses considerable convergence

[44] Shown at the quarterly rate of 0.005 in the Table.

problems for the model.[45] This result compares well with the approach of Corrado and Holly (2003) who show not merely that the Phillips curve can be approximated by a three piece function, similar in concept to this corridor approach, but that a three piece feedback rule for monetary policy provides an appropriate characterisation for policy. Here again, responses are greatest above the upper threshold and lowest between the two thresholds both for the UK and the US.[46]

5 The joint effect

Taking the Phillips curve, Okun curve, IS curve and monetary reaction function 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 curve that we have explored appear to be primarily cyclical in character. The asymmetries in the Okun curve, on the other hand are

[45] We have undertaken some limited experiments in estimating 'corridor' Taylor rules with monthly data for the 15 EU member states, which show similar results. Responses to output gaps of less than 2% are weaker and generally of low significance in the period 1993.1–1998.12. Responses to output gaps above the corridor were however stronger than to those below it but in both cases the results were clearly significant at the 1% level. The inflation target could be represented by the German inflation rate. Within the 2% difference corridor, responses were not significantly different from zero, while outside it they were, with upside inflation having a coefficient three times as large as that for the downside. Monthly models create severe problems not just for data but with the timing of monetary policy decisions. At a monthly level there is clear inertia in decision-making, which is not so evident from quarterly data. There is a clear relationship between the number of policy rate changes in a given year and both the inflation differential with Germany and the size of the output gap. Thus the larger the gaps, the more policy rate changes are required to close them.

[46] Gerlach (2000a) explores the idea that policy makers are asymmetric in their concerns over positive and negative output gaps. He suggests that there is evidence from the period 1960–1979 in the US that the Federal Reserve reacted more strongly to negative than positive output gaps (thereby giving an inflationary bias to policy). Surico (2002) suggests that this asymmetry has become sharper since 1979, particularly with respect to the output gap – the policy preference for inflation puts a higher weight on correcting inflation when it is above the target rather than below, thus tending to offset the output gap asymmetry. (Since Surico's responses are quadratic, bigger deviations receive a more than proportionate response than do small ones.) Gerlach and Smets (1999) provides one of the best known assessments across the euro area.

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).

We therefore estimate the four equations (3.1), (4.4), (4.2) and (3.4) as a system using SUR for the period 1985Q1 to 2001Q3. The estimates of the coefficients from the individual equations are stacked in that order in Table 8. Columns 1, 3 and 5 use the deviation of unemployment from its Hodrik-Prescott filtered trend in the Phillips curve, while the other three columns show the results for the output gap. The results are similar to those obtained when estimating the equations separately. The asymmetry appears to be concentrated in the Phillips curve (asymmetry due to unemployment dispersion in the Okun curve could not be included with these quarterly data) when using this full sample. However, if we confine the estimation to the period after the ERM crisis (columns 5 and 6) then there is asymmetry in the Okun curve as well. Including the years when the euro area was in operation does not appear to have a major effect. We have used rolling regressions to test for other sources of instability. We therefore proceed with the 1993–2001 estimates as being more informative about recent and likely future behaviour in the euro area.

There are various ways in which we could shock the system to illustrate the effects of asymmetry. In Figure 6 we show the impact of a one percentage point shock in OECD GDP, applied in 1995 to the model in column 6 of Table 8, on unemployment and the price level. The solid line shows the linear version of the model and the dotted line the asymmetric version. Initially there is little impact on the path of unemployment, although inflation rises more slowly under the asymmetric model during the first two years. The pattern then changes for the rate of inflation, which thereafter is higher and after three years the price level itself is higher. Unemployment shows the more striking movement as there is a clear regime shift after 10 quarters. The simulation is data dependent and at this point the output gap crosses the threshold. There is some variation in the date of the switch for various countries. Germany for example only sees unemployment fall by two thirds of the average, with a more adverse effect on prices that does not involve lower inflation at any stage in the asymmetric case. Finland on the other hand is very similar to the average.

Our model is only illustrative and we can increase the effects by using larger shocks, altering their timing to affect when the regime switches or adding the asymmetric version of the reaction function. If instead of using the panel data model we were to allow different parameter values for each individual country, as explored in Section 3, then we would observe a much bigger variety of timing and size of regime shifts even under a single monetary policy reaction function.

Our analysis does not offer much scope for a discussion of the causes of asymmetry. 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 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.[47] 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, in contrast to Laxton et al (1997), emphasises the potential problem of aggregation that we have outlined for the euro area.

We have only explored some forms of asymmetry across the cycle. Lo and Piger (2002) offer a more complex analysis by using a regime-switching model for the US, which does not seek to explain why the regime changes but just the nature of the asymmetries. They find that policy actions are more likely to lead output changes in a downturn than an upturn and that large or contractionary policy actions are more likely to lead output changes than those that are small or expansionary. Unfortunately the problems of adjusting to policy under EMU will be long in the past before there is an equivalent 45 years of quarterly data to use in similar estimation for the European countries.

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

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, using arithmetic weights to add effects across countries in order to determine area wide monetary policy could produce erroneous results.[48] 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.[49] Differences in the speed and extent of the transition mechanism within countries will matter rather than differences according to where they are in the cycle as well. The problem still will not disappear if the shock falls on countries such as Spain where the impact of disinflationary policy is slower and milder than elsewhere.

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.[50] 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.[51] Our concern is simply that if arithmetic weights are used in a nonlinear and asymmetric world there is a danger of generating inefficient outcomes.[52]

We primarily focus on asymmetries stemming from the behaviour of the labour market.[53] Rapid downturns in the economy appear to have more than proportionate downward effects on unemployment, partly because of mismatch

---

[48] The ECB uses both area-wide and multi-country models (Fagan et al, 2001) so this problem can be addressed.

[49] However, Artis et al (1999) also find 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.

[50] 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.

[51] 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.

[52] Tarkka (1998) has already shown that inappropriate voting systems could make the result even worse.

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

between the sectors and regions where the jobs and unemployed lie. This effect is 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 Eurosystem 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 to 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. These interventions may take the form of changing labour market arrangements or altering the structure of financial contracts so as to affect the real impact of monetary policy. The 'open method of co-ordination' facilitates this form of policy learning in the EU. 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 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).[54] 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 rather faster than the rest of the euro area that recent growth-inflation combinations have become more favourable (Mayes and Suvanto, 2002). 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. Our estimates of a monetary reaction function for the euro as part of the model suggest that policy has indeed been asymmetric. However it is not simply that the authorities have reacted more strongly to high rather than low inflation but that they have reacted more strongly still to deflation. Thus what we see is a 'corridor' pattern, where within the corridor the response is relatively mild and outside the response is much more aggressive. Given that the Eurosystem has adopted a target range for inflation over the medium term and not a single midpoint value, this corridor may turn out to be a better description of future policy than some simple linear reaction function. The more aggressive approach to the threat of deflation may reflect the 'zero bound' problem. As nominal interest rates approach zero traditional monetary policy reaches its limit and recourse has to be made to other measures that affect the exchange rate, other asset prices and the rate of inflation. The wish to avoid entering this difficult zone coupled with the real costs of deflation may help explain the vigour of the pre-emptive response.

Some of the asymmetry will be in omitted parts of the economic system, the most obvious of which is counter-cyclical fiscal policy. In a companion paper (Mayes and Virén, 2003) we show, using annual data for all the EU countries

[54] 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.

except Luxembourg over the years 1960–1999, that while the automatic stabilisers tend to be fairly symmetric across the growth and contraction phases of the cycle, discretionary fiscal policy has not. The asymmetry applies rather more to revenues than to expenditures and appears to relate to a tendency to cut tax rates more in the growth phase than is sustainable over the cycle as a whole. There is some matching failure to restrain expenditures in the upswing compared to the downswing. Although there has been a trend towards symmetry, the suspension of the operation of the Excessive Deficit Procedure in 2003 shows that these pressures still apply. Monetary policy has to handle the consequences. One feature of ECB pronouncements has been warnings on the need to respect the requirements of the SGP. This again would reinforce the 'corridor' finding as fiscal policy has been more controversial towards the extremes of the cycle with case of Ireland in the up phase and Portugal, France and Germany in the down phase.

Table 1. **Estimates of an IS curve with panel data for the EU**

	∇y_{-1}	re_{-2}	rr_{-2}	$\nabla yoecd_{-1}$	R^2/SEE/DW	λ/period
EMU10	.833	.012	–.039	.334	.781/.699/2.06	3.3
	(26.76)	(3.47)	(2.43)	(4.36)		Short
EMU10:GLS	.801	.055	–.096	.138	.722/.066/1.88	1.7
	(33.61)	(4.48)	(1.96)	(4.31)		Long
EMU10:SUR	.764	.029	–.112	.155	.720/.066/1.81	3.9
	(31.95)	(1.77)	(2.10)	(3.84)		Long
EU11	.823	.014	–.037	.250	.759/.727/2.17	2.6
	(25.98)	(4.04)	(3.14)	(3.29)		Short
EU13	.812	.012	–.039	.301	.760/.721/2.04	3.3
	(29.37)	(3.85)	(3.58)	(4.45)		Short
EU13:GLS	.838	.012	–.023	.273	.803/.718/2.08	1.9
	(40.57)	(4.81)	(2.18)	(5.04)		Short
EU13:SUR	.812	.011	–.012	.265	.757/.725/2.02	1.1
	(35.70)	(4.28)	(1.34)	(4.28)		Short
Agriculture	.347	.010	–.010	.649	.152/4.532/1.77	1.0
	(3.90)	(0.42)	(0.13)	(1.32)		Short
Industry	.701	.026	–.056	.643	.658/1.444/2.17	2.2
	(19.08)	(3.78)	(2.25)	(4.37)		Short
Construction	.671	.005	–.089	1.017	.525/2.785/2.35	18
	(11.55)	(0.40)	(1.52)	(3.39)		Short
Services	.828	.006	–.028	.191	.703/.670/2.25	4.7
	(24.80)	(1.80)	(1.66)	(2.69)		Short

All estimates are OLS unless stated otherwise. The dependent variable ∇y_t, is the output gap constructed from the HP filter. rr is the real interest rate, re the real exchange rate with respect to the US dollar and ∇y oecd the output gap for OECD GDP. The pooled cross-country data consist of observations for 1987.1–1997.4 for the 'Short' sample and 1985.1–2001.3 for the 'Long' sample. In the Long sample the interest rate is lagged an extra quarter. 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 for the Short sample and 725 for the Long sample. 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 in parentheses are t-ratios.

Table 2. **Estimates of the expanded IS curve with panel cross-country data**

	∇y	Δy
Y_{-1}	.713	–.087
	(25.73)	(2.30)
rr	–.012	–.087
	(1.11)	(2.31)
re	.001	.027
	(0.44)	(2.07)
Yoecd	.285	.511
	(3.04)	(5.20)
Δhp	.050	.075
	(4.69)	(5.96)
Δsp	.009	.013
	(3.04)	(3.97)
R^2	.679	.159
100*see	.77	.86
DW	2.06	1.99
period	1985.1–2003.1	
N/obs	13/712	

Variables are as defined in the text, y is log GDP, ∇y is the log output gap, Y_{-1} denotes the lagged output variable and Yoecd, the output variable for the OECD as a whole, both defined compatibly depending upon whether the output variable is the output gap or the change in output as indicated by the column headings. N denotes the number of countries and obs the total number of observations in the regression.

Model is estimated by SUR jointly with a second equation of the form $\Delta hp_t = \beta_0 + \beta_1 \Delta hp_{t-1} + \beta_2 rr_t + \beta_3 Y_t + \beta_4 \Delta pc_t + \varepsilon_t$.

Table 3. **Phillips curve estimates from panel data**

	OLS	GLS	SUR	OLS	GLS	SUR
Δp_{-1}	.199	.173	.147	.195	.178	.158
	(5.05)	(5.23)	(4.11)	(5.11)	(5.32)	(4.88)
Δp_{-2}	.249	.256	.208	.239	.247	.201
	(5.68)	(7.29)	(6.03)	(5.49)	(7.14)	(5.90)
Δm	.013	.007	.006	.019	.014	.009
	(1.46)	(2.00)	(1.26)	(2.12)	(2.69)	(1.96)
Δm_{-1}	.020	.013	.011	.020	.013	.015
	(2.54)	(3.95	(2.38)	(2.66)	(3.29)	(3.13)
∇x^{-}	–.022	–.034	.006	–.177	–.145	–.081
	(0.60)	(1.48)	(0.22)	(2.58)	(2.78)	(1.96)
∇x^{+}	.163	.159	.099	-.078	-.072	-.060
	(4.12)	(5.20)	(4.29)	(1.71)	(1.87)	(1.59)
R^2	.373	.373	.373	.365	.363	.355
SEE	.006	.006	.006	.006	.006	.006
DW	1.967	2.027	1.907	2.042	2.012	1.935
N	732	732	732	770	770	770
Wald	8.15	19.51	5.12	0.75	.084	.109
	(.004)	(.000)	(.024)	(.401)	(.357)	(.741)
Def. of ∇x	∇y	∇y	∇y	∇u	∇u	∇u

p denotes consumer prices, m import prices, ∇y the HP output gap for GDP, ∇u is the deviation of unemployment from the mean level of unemployment over the sample. The data period stretches from 1985.1 to 2001.3. t values in parentheses using heteroscedasticity consistent standard errors. Wald test for equality of coefficients on ∇x^{-} and ∇x^{+} p-value in parenthesis.

Table 4. **Estimates of the Phillips curve with regional EU data**

	(1)	(2)	(3)	(4)	(5)	(6)
Δp^e	.655	.649	.513	.488		.522
	(12.42)	(10.17)	(12.72)	(11.77)		(13.76)
Δp_{-1}	.254	.214	.191	.143	.567	.187
	(5.72)	(3.92)	(5.26)	(3.66)	(23.89)	(5.31)
Δm	.058	.056	.063	.068	.085	.065
	(6.56)	(5.43)	(10.14)	(9.25)	(13.19)	(10.54)
U	–.053	–.003	–256	–248	–290	–306/–.260
	(3.36)	(0.23)	(10.06)	(12.84)	(11.82)	(11.66/12.00)
Umax-Umin	.068		.147		.154	.130
	(4.81)		(6.47)		(6.86)	(5.91)
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)
R^2	.868	.866	.914	.918	.885	.918
SEE	.963	1.073	.816	.878	.938	.797
DW	1.526	1.289	1.800	1.590	1.928	1.822
Dummies	No	No	Yes	Yes	Yes	Yes
Obs	153	143	153	143	153	153

All estimates are SUR estimates. Δp^e denotes expected inflation (OECD forecasts), m import price inflation, Δp is inflation in consumption prices, U the aggregate unemployment rate, Umax-Umin the range of regional unemployment rates, Usd the corresponding standard deviation and t time trend. Column (6) 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 (second coefficient) the 10.8% threshold. The hypothesis that the coefficients are equal can be rejected with marginal probability of 0.0013% using the F test.

Table 5. **Estimates of sectoral phillips curves**

	Δp_{-1}	Δp_{-2}	Δm	Δm_{-1}	∇y^{-}	∇y^{+}	R^2/SEE/DW
							$F(\nabla y^{-}=\nabla y^{+})$
GDP	.288	.259	.064	.017	.027	.090	.580/336/2.00
	(8.30)	(7.26)	(6.81)	(1.97)	(1.31)	(4.25)	.000
a	.284	.274	.060	.016	.005	.020	.570/.543/1.93
	(8.04)	(7.56)	(6.21)	(1.81)	(1.09)	(3.36)	.027
i	271	.261	.056	.014	–.005	.067	.576/340/1.30
	(6.66)	(5.70)	(5.71)	(1.59)	(0.38)	(4.30)	.002
c	.293	.258	.060	.009	_.010	.031	.590/332/1.93
	(8.08)	(7.07)	(6.08)	(2.03)	(1.34)	(3.91)	.002
S	.285	.269	.067	.018	.047	.077	.575/.539/1.98
	(8.17)	(7.56)	(7.09)	(2.08)	(1.79)	(3.09)	.005

p denotes consumer prices, m import prices and ∇y the HP output gap for GDP, agriculture, industry, construction, services (a/i/c/s). $F(\nabla y^{-} = \nabla y^{+})$ denotes probability of the F test statistics for the hypothesis that the coefficients of ∇y^{-} and ∇y^{+} are equal. The data cover the period 1987:1–1998:4 only. The threshold is $\nabla y = 0$. t values in parentheses using heteroscedasticity consistent standard errors. SUR estimates.

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

	$\Delta y^{+}(0)$	$\Delta y^{-}(0)$	$\Delta y^{+}(c)$	$\Delta y^{-}(c)$	F
Austria	–.039	–.512	–.050	–.075	14.53
	(3.76)	(–.047)	(5.03)	(3.93)	
Belgium	–.026	–.125	–.038	–.070	18.29
	(2.33)	(2.85)	(4.42)	(4.66)	
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)	
Netherlands	–.023	–.182	–.048	–.123	112.86
	(0.95)	(1.22)	(2.73)	(4.07)	
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)	

Numbers inside parentheses are t-ratios $\Delta y^{+}(0)$ and $\Delta y^{-}(0)$ denote estimates with zero threshold and $\Delta y^{+}(c)$ and $\Delta y^{-}(c)$ estimates with nonzero (estimated) threshold value. The parameters are derived from the following estimating equation $\Delta u_t = a_0 + a_1\Delta y^{+}_t + a_2\Delta y^{-}_t + a_3\Delta pop_t + a_4\varepsilon_{t-1} + \eta_t$, 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 η the error term. F is the F(1,31) test for the equality of the coefficients of Δy^{+} and Δy^{-} in the case of nonzero threshold. Estimates are based on annual OECD data for 1961–1997.

Table 7. **Okun curve estimates from panel data**

	OLS	GLS	SUR	OLS	GLS	SUR
U_{-1}	.960	.960	.971	.739	.794	.782
	(82.33)	(134.31)	(154.46)	(27.62)	(56.51)	(51.10)
∇y^{-}	–.219	–.194	–.135	–.173	–.135	–.134
	(6.01)	(10.74)	(7.23)	(6.28)	(10.87)	(9.16)
∇y^{+}	–.007	–.025	–.040	–.150	–.131	–.137
	(0.20)	(1.51)	(2.20)	(5.64)	(9.79)	(9.35)
Δpop–1	.047	.046	–.026	.025	.037	–.032
	(1.17)	(1.47)	(0.80)	(0.66)	(1.17)	(1.15)
R2	.990	.990	.990	.823	.822	.8722
SEE	.427	.427	.430	.344	.347	.346
DW	1.600	1.586	1.555	1.979	2.024	2.011
N	750	750	750	750	750	750
Wald	13.08	32.25	9.30	0.21	0.03	0.02
	(.000)	(.000)	(.002)	(.648)	(.865)	(.886)
Dep.var.	u	u	u	∇u	∇u	∇u

Dependent variable U is either the unemployment rate u or the corresponding HP residual ∇u. ∇y^{-}(∇y^{+}) denotes the negative (positive) values of HP residuals in terms of log GDP. Wald denotes the Wald test statistic for the equality of the coefficients of ∇y^{-} and ∇y^{+}.

Table 8. **Simultaneous system estimation for all four equations from panel data**

	SUR	SUR	SUR	SUR	SUR	SUR
y_0	0.031	.031	.033	.030	.072	.071
	(4.16)	(4.12)	(5.16)	(4.93)	(15.15)	(15.18)
∇y_{-1}	.759	.757	.767	.764	.714	.714
	(52.30)	(52.40)	(58.87)	(57.49)	(113.09)	(111.56)
$\nabla yoecd_{-1}$	.181	.188	.195	.206	.184	.183
	(6.91)	(7.26)	(8.17)	(8.74)	(13.33)	(13.42)
rr_{-3}	–.191	–.195	–.156	–.156	–.299	–.299
	(5.58)	(5.72)	(5.78)	(5.85)	(39.13)	(38.08)
re_{-2}	–.034	–.032	–.035	–.033	-.077	–.078
	(4.00)	(3.95)	(5.02)	(4.78)	(14.87)	(14.91)
u_0	–.013	–.014	–.014	–.014	–.008	–.010
	(1.66)	(1.70)	(1.70)	(1.64)	(1.30)	(1.51)
u_{-1}	.743	.740	.743	.742	.677	.677
	(81.46)	(80.53)	(90.76)	(89.06)	(94.32)	(91.00)
∇y^{-}	–.169	–.171	–.173	–.174	–.205	–.206
	(19.11)	(18.87)	(21.32)	(20.82)	(31.90)	(30.19)
∇y^{+}	–.147	–.148	–.151	–.151	–.131	–.130
	(16.00)	(15.98)	(18.33)	(18.13)	(13.33)	(12.58)
Δpop_{-1}	.038	.031	.022	.017	.084	.085
	(2.17)	(1.79)	(1.40)	(1.15)	(3.63)	(3.61)
p_0	.003	.002	.003	.003	.003	.003
	(11.52)	(9.20)	(12.69)	(9.93)	(26.88)	(25.33)
Δp_{-1}	.254	.261	.263	.271	.097	.085
	(11.79)	(11.51	(13.17)	(12.69)	(9.84)	(8.24)
Δp_{-2}	.313	.329	.318	.337	.268	.259
	(15.12)	(15.14)	(16.45)	(16.32)	(27.56)	(25.51)
Δm	.019	.015	.033	.028	.028	.027
	(6.66)	(5.13)	(11.02)	(8.90)	(19.59)	(18.03)
Δm_{-1}	.018	.018	.027	.028	.023	.018
	(5.72)	(6.09)	(8.84)	(9.13)	(15.52)	(11.45)
x^{-}	–.115	–0002	–.111	.019	–.072	–.017
	(4.66)	(0.06)	(5.01)	(1.28)	(5.36)	(3.12)
x^{+}	.052	.105	–.082	.103	–.012	.041
	(2.25)	(7.27)	(4.00)	(7.78)	(1.66)	(5.09)
r_{-1}	.853	.853	.834	.833	.772	.771
	(89.20)	(88.56)	(84.84)	(82.65)	(252.43)	(238.45)
Δp	.212	.212	.222	.219	.390	.391
	(8.27)	(8.12)	(8.68)	(8.37)	(66.80)	(65.89)
∇y	.214	.212	.230	.227	.159	.159
	(15.77)	(15.45)	(17.61)	(17.01)	(41.77)	(42.13)
period	1985–2001	1985–2001	1985–1998	1985–1998	1993–2001	1993–2001
def. of x	∇u	∇y	∇u	∇y	∇u	∇y
λ	5.70	6.02	4.42	4.70	3.86	3.85
Wald $b_1 = b_2$	2.32 (.128)	2.31 (.124)	2.66 (.103)	2.88 (.089)	30.28 (.000)	.27.90 (.000)
Wald $c_5 = c_6$	2.74 (.098)	17.92 (.000)	0.74 (.389)	13.13 (.003)	11.54 (.001)	25.34 (.000)

y_0, u_0 and p_0 denote the constant terms of IS, Okun and Phillips curves, respectively. In the Taylor rule (last three rows of estimates), the intercept r_0 was allowed to vary from country to country. Number of observations 720.

Table 9. **Selected reaction function estimates**

	(1)	(2)
r_{t-1}	.771	.863
	(238.15)	(63.54)
Δp_t	.391	
	(65.89)	
$\Delta p_t \mid \Delta p_t < .005$		.281*
		(2.30)
$\Delta p_t \mid \Delta p_t > .005$		.164
		(3.30)
Δy_t	.159	
	(42.13)	
$\nabla y_t \mid \nabla y_t < 0$		.112*
		(2.65)
$\nabla y_t \mid \nabla y_t > 0$		.381
		(5.72)

The Wald test result for the equality of the two respective coefficients is 927 (.009), Thus, the linear model is rejected at the 1 per cent significance level with the chi-square distribution. All estimates are derived form the whole system of equations. Data period is 1993–2001.

Table 10. **Corridor reaction functions**

$\Delta p_t \mid \Delta p_t < 0$	.602
	(3.63)
$\Delta p_t \mid 0 < \Delta p_t < .01$	.153
	(3.32)
$\Delta p_t \mid \Delta p_t > .01$	.230
	(6.60)
$\nabla y_t \mid \nabla y_t < -.02$	.249
	(9.32)
$\nabla y_t \mid -02 < \nabla y_t < -.02$	.074
	(3.80)
$\nabla y_t \mid \nabla y_t > .02$	.147
	(0.41)

Data period is 1993–2001, maximum likelihood, reaction functions only.

Figure 1. **Confidence intervals for estimates of λ (short sample)**

EU10 = EMU countries in the sample, EU13 = EU countries, SC = single countries, LS = least squares, GLS = generalised least squares, SUR = seemingly unrelated regression estimates

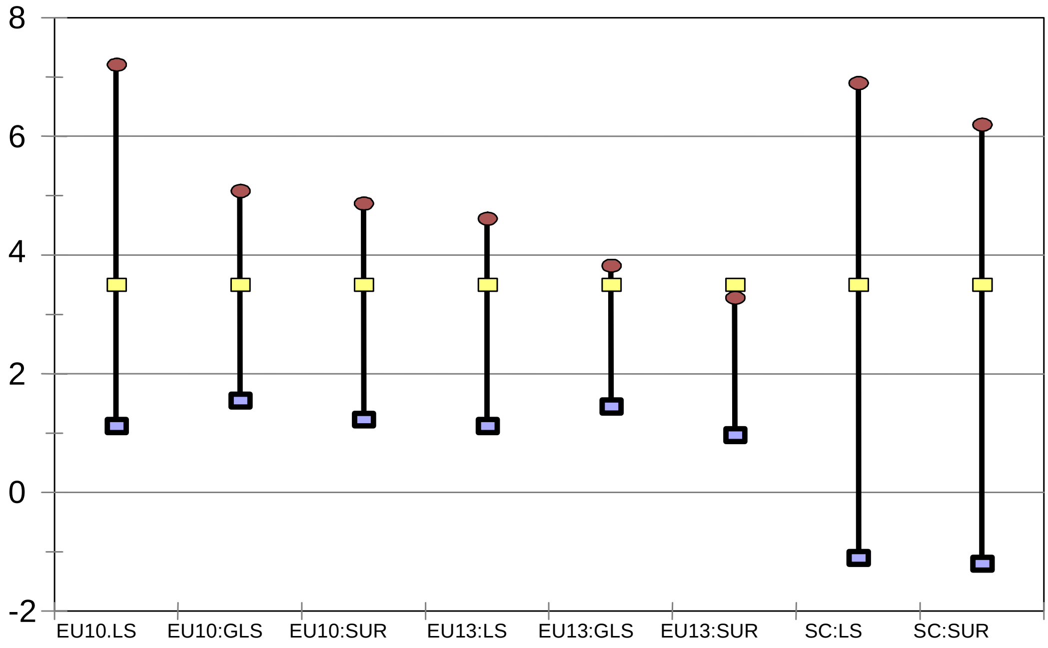


Figure 2. **Values of λ for different sectors in Finland**

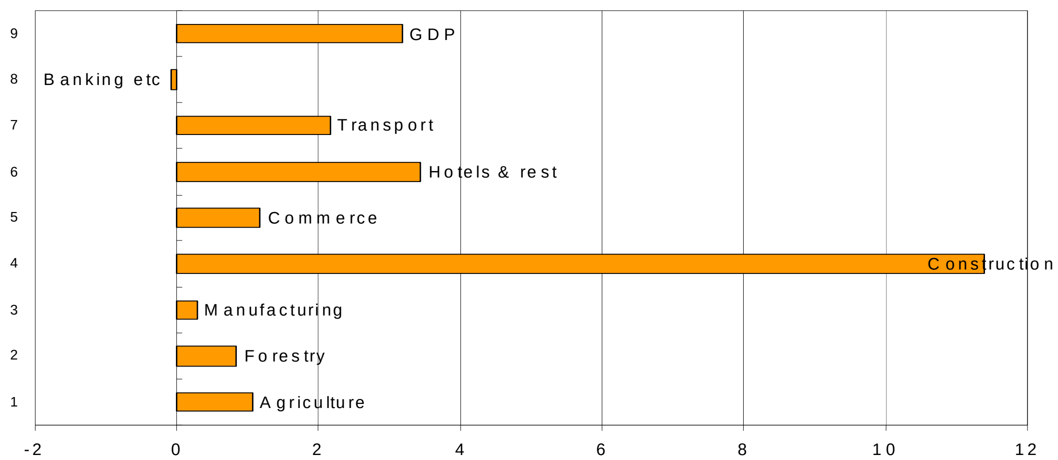
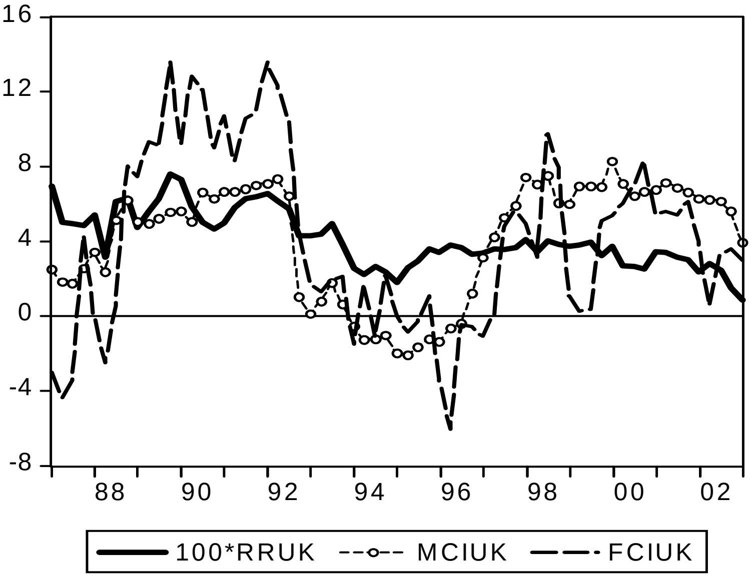


Figure 3. **Illustration of the difference between the real interest rate (rr), the monetary conditions index and the financial conditions index (FCI) for the UK** (weights are the pooled cross-country weights)



RR= real interest rate
MCI = weighted average of the real interest rates and the real exchange rate (using estimated panel data weights)
FCI = weighted average of rr, re and Δhp (using estimated panel data weights)

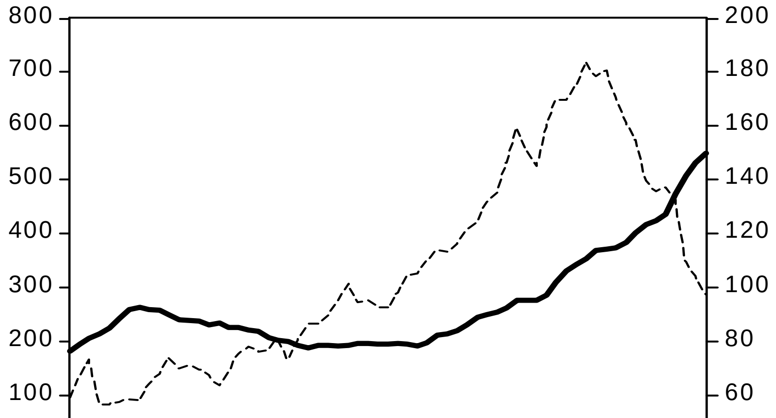


Figure 4. **Estimates of simple nonlinear Phillips curve for the EU**

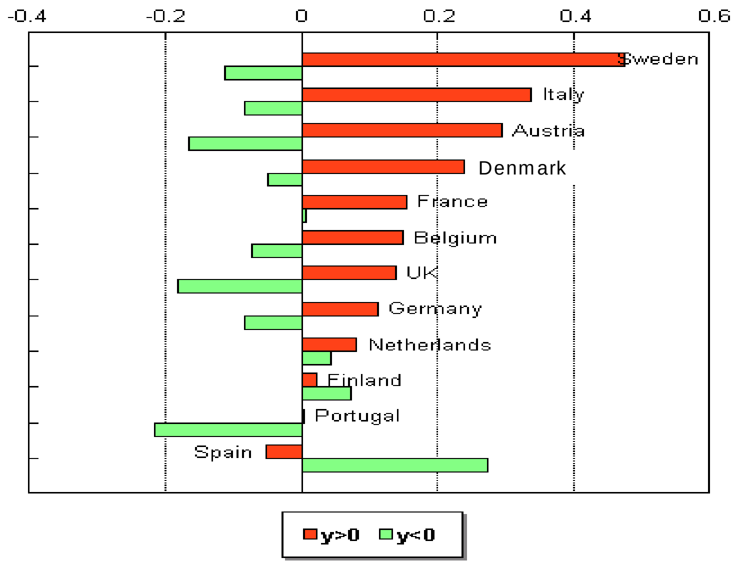


Figure 5. **Linearity and nonlinearity in the Phillips curve and the setting of policy**

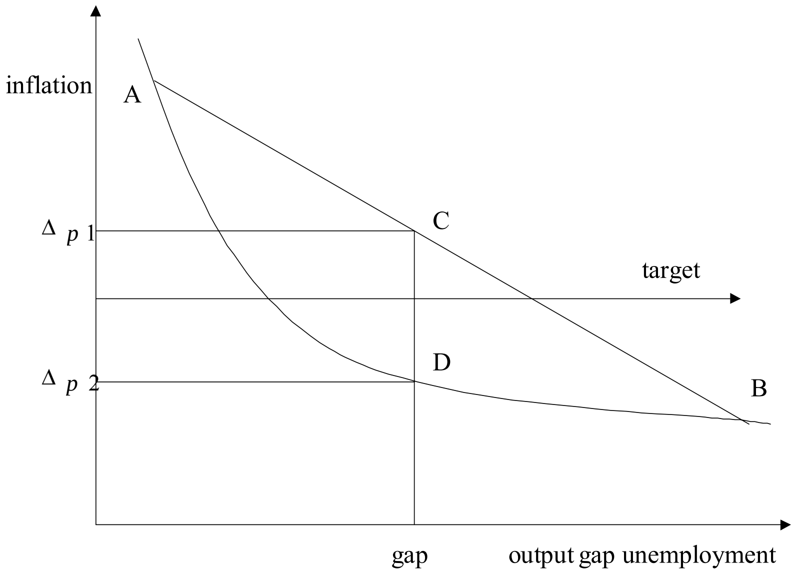
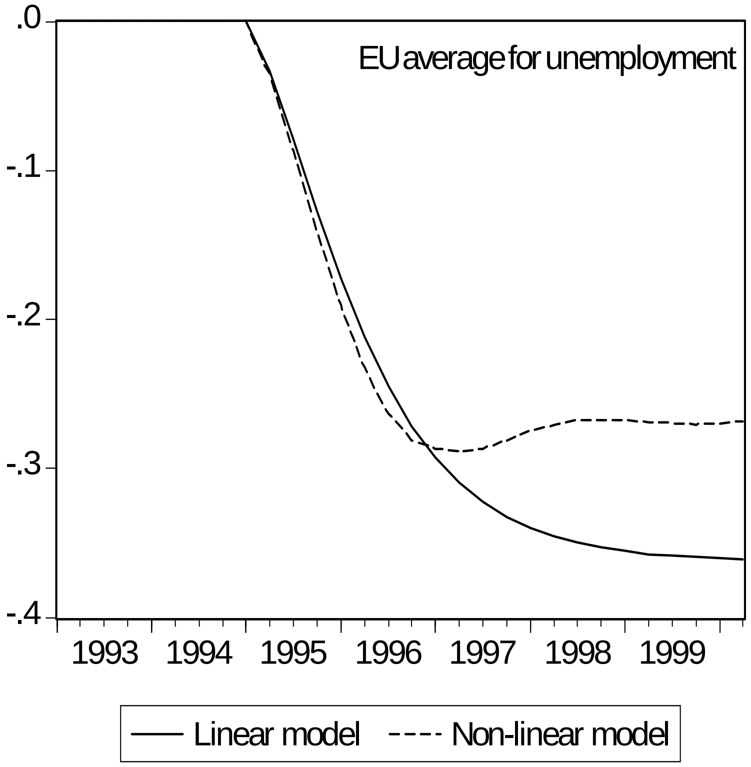
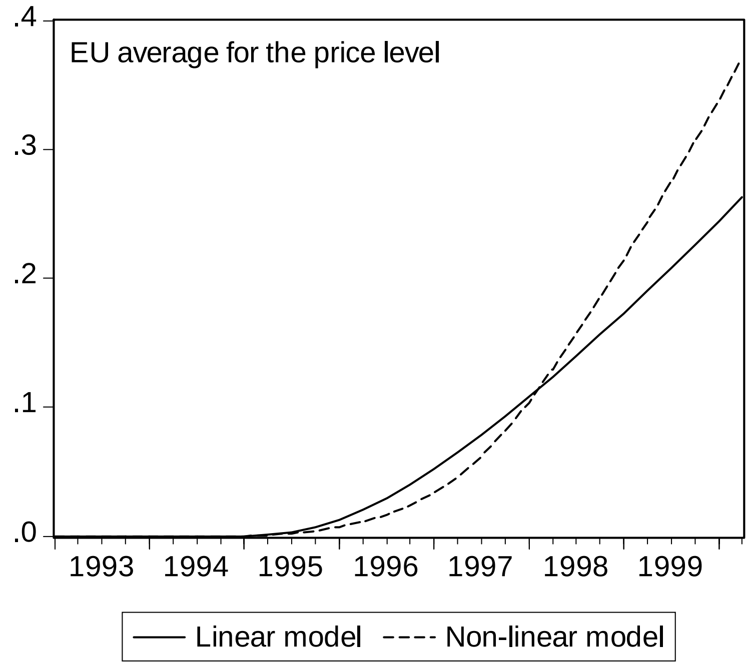


Figure 6. **Impact of a one percentage point increase in OECD GDP in 1995**





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 and 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.

Barata, J.M. – Pacheco, L.M. (2003) **Asset Prices and Monetary Policy: Wealth Effects on Consumption.** 20th Symposium on Banking and Monetary Economics, University of Birmingham, June.

Bayoumi, T. – Edison, H. (2003) **Is Wealth Increasingly Driving Consumption?** DNB Staff Report 101, De Nederlandsche Bank.

BIS (2003) Annual Report, p. 129, Basel.

Blinder, A.S. – Solow, R. (1973) **Does Fiscal Policy Matter?** Journal of Public Economics, vol. 2, 319–337.

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.

Collins, S. – Siklos, P. (2002) **Optimal Reaction Functions, Taylor's rule and Inflation Targets: the experience of dollar bloc countries.** Mimeo, Wilfrid Laurier University.

Corrado, L. – Holly, S. (2003) **Non Linear Phillips Curve, Mixing Feedback Rules and the Distribution of Inflation and Output.** CEIS Tor Vergata Research Paper 37, October.

Davis, S.J. – Haltiwanger, 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 Staff Papers, vol. 44, 249–282.

De Grauwe, P. – Sénégas, M.-A. (2003) **Monetary Policy in EMU When the Transmission is Asymmetric and Uncertain.** CESifo Working Paper 891, March.

Department of the Treasury (1996) **Documentation of the Treasury Macroeconomic (TRYM) Model of the Australian Economy.** Canberra.

Diebold, F. – Rudebusch, G. (1999) **Business Cycles: durations, dynamics and forecasting.** Princeton: Princeton University Press.

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.

ECB (2003) **Recent Trends in Residential Property Prices in the Euro Area.** Monthly Bulletin, May, 1–12.

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.

Enders, W. – Siklos, P. (2001) **Cointegration and Threshold Adjustment.** Journal of Business and Economic Statistics, vol. 19 (2), 166–176.

Fabiani, S. – Morgan, J. (2003) **Aggregation and Euro Area Phillips Curves.** ECB Working Paper 213, February.

Fagan, G. – Henry, J. – Mestre, R. (2001) **An Area-wide Model (AWM) for the Euro Area.** ECB Working Paper 42.

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

Gaiotti, E. – Generale, A. (2001) **Does Monetary Policy Have Asymmetric Effects? A Look at the Investment Decisions of Italian firms.** ECB Working Paper 110.

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

Gerlach, S. (2000a) **Asymmetric Policy Reactions and Inflation.** Mimeo, BIS, April.

Gerlach, S. (2000b) **The Taylor Rule and Interest Rates in the EMU area.** Economics Letters, vol. 67, 165–171.

Gerlach, S. – Smets, F. (1999) **Output Gaps and Monetary Policy in the EMU Area.** European Economic Review, vol. 43, 801–812.

Goodhart, C. – Hofmann, B. (2000) **Asset Prices and the Conduct of Monetary Policy.** Sveriges Riksbank and Stockholm School of Economics conference on Asset Markets and Monetary Policy, Stockholm, June.

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 Curve and Monetary Policy.** Journal of Monetary Economics, vol. 44, 259–278.

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.

Hosomatsu, Y. (1980) **Asymmetric Loss Function and Optimal Policy Under Uncertainty: A Simple Proof.** Decision Sciences, vol. 11, 577–585.

Huang, A. – Margaritis, D. – Mayes, D. (2001) **Monetary Policy Rules in Practice: evidence from New Zealand.** Bank of Finland Discussion Paper 18/2001.

Issing, O. – Gaspar, V. – Angeloni, A. – Tristani, O. (2001) **Monetary Policy in the Euro Area.** Cambridge: Cambridge University Press.

Karanassou, M. – Sala, H. – Snower, D. (2003) **The European Phillips Curve: Does the NAIRU exist?** IZA Discussion Paper 876 (September).

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.

King, M. (1994) **Debt Deflation: Theory and Evidence.** European Economic Review, vol. 38, 419–435.

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.** Weltwirtschafliches Archiv, vol. 127, 452–471.

Laxton, D. – Meredith, G. – Rose, D. (1995) **Asymmetric Effects of Economic Activity on Inflation.** IMF Staff Papers, vol. 42(2), 344–379.

Laxton, D. – Rose, D. – Tambakis, D. (1999) **The US Phillips Curve: the case for asymmetry.** Journal of Economic Dynamics and Control, vol. 23, 1459–1485.

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 93-6.

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

Lo, M.C. – Piger, J. (2002) **Is the Response of Output to Monetary Policy Asymmetric? Evidence from a Regime-Switching Model.** Federal Reserve Bank of St Louis Working Paper no 22.

Loupias, C. – Savignac, F. – Sevestre, P. (2001) **Monetary Policy and Bank Lending in France: are there asymmetries?** ECB Working Paper 101.

Ludwig, A. – Sløk, T. (2002) **The Impact of Changes in Stock Prices and House Prices on Consumption in OECD Countries.** IMF Working Paper, 02/1.

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. – Halme, L. – Liuksila, A. (2001) **Improving Banking Supervision.** Basingstoke: Palgrave.

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. – Suvanto, A. (2002) **Beyond the Fringe: Finland and the Choice of Currency.** Journal of Public Policy, vol. 22(2), 161–182.

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.** In (Mahadeva, L. and Sterne, G. eds.), Monetary Policy Regimes, London: Routledge.

Mayes, D.G. – Virén, M. (2002) **Financial Conditions Indexes.** Economia Internazionale, vol. 55 (4), 521–550.

Mayes, D.G. – Virén, M. (2003) **Pressures on the Stability and Growth Pact from Asymmetries in Policy.** Paper presented at 'Building EU Economic Government: Revising the Rules?', UACES conference, NYU in London, 25/6 April, forthcoming in Journal of European Public Policy.

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

Meyer, L.H. – Swanson, E.T. – Wieland, V.W. (2001) **NAIRU Uncertainty and Nonlinear Policy Rules.** Mimeo, Federal Reserve Board, January.

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?** Board of Governors of the Federal Reserve System, Finance and Economics Discussion Paper no. 20.

Orphanides, A. – Wilcox, D. (2002) **The Opportunistic Approach to Disinflation.** International Finance, vol. 5, 47–51.

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.

Schaling, E. (2002) **The Nonlinear Phillips Curve and Inflation Forecast Targeting: Symmetric versus Asymmetric Monetary Policy Rules.** Mimeo, Rand Afrikaans University.

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.

Surico, P. (2002) **US Monetary Policy Rules: the Case for Asymmetric Preferences.** Fondazione Eni Enrico Mattei working paper 66.2002.

Svensson, L.E.O (1997) **Inflation Forecast Targeting: Implementing and Monitoring Inflation Targets.** European Economic Review, vol. 41(6), 1111–1146.

Tarkka, J. (1998) **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.

Virén, M. (2001) **Fiscal Policy, Automatic Stabilisers and Policy Coordination in EMU.** In (A. Brunila, M. Buti and M. Franco, eds.), The Stability and Growth Pact, Basingstoke: Palgrave.

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

Walsh, C. (2001) **The Output Gap and Optimal Monetary Policy.** Mimeo, University of California Santa Cruz.

Waud, R.N. (1970) **Public Interpretation of Federal Reserve Discount Rate Changes: Evidence on the 'Announcement Effect'.** Econometrica, vol. 38 (2), 231–250.

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

Woodford, M. (1999) **Optimal Monetary Policy Inertia.** NBER Working Paper 7261.

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

BANK OF FINLAND DISCUSSION PAPERS

ISSN 0785-3572, print; ISSN 1456-6184, online

1/2004 Jukka Railavo **Stability consequences of fiscal policy rules.** 2004. 42 p. ISBN 952-462-114-2, print; ISBN 952-462-115-0, online. (TU)

2/2004 Lauri Kajanoja **Extracting growth and inflation expectations from financial market data.** 2004. 25 p. ISBN 952-462-116-9, print; ISBN 952-462-117-7, online. (TU)

3/2004 Martin Ellison – Lucio Sarno – Jouko Vilmunen **Monetary policy and learning in an open economy.** 2004. 24 p. ISBN 952-462-118-5, print; ISBN 952-462-119-3, online. (TU)

4/2004 David G. Mayes **An approach to bank insolvency in transition and emerging economies.** 2004. 54 p. ISBN 952-462-120-7, print; ISBN 952-462-121-5, online. (TU)

5/2004 Juha Kilponen **Robust expectations and uncertain models – A robust control approach with application to the New Keynesian economy.** 2004. 43 p. ISBN 952-462-122-3, print; ISBN 952-462-123-1, online. (TU)

6/2004 Erkki Koskela – Roope Uusitalo **Unintended convergence – how Finnish unemployment reached the European level.** 2004. 32 p. ISBN 952-462-124-X, print; ISBN 952-462-125-8, online. (TU)

7/2004 Berthold Herrendorf – Arilton Teixeira **Monopoly rights can reduce income big time.** 2004. 38 p. ISBN 952-462-126-6, print; ISBN 952-462-127-4, online. (TU)

8/2004 Allen N. Berger – Iftekhar Hasan – Leora F. Klapper **Further evidence on the link between finance and growth: An international analysis of community banking and economic performance.** 2004. 50 p. ISBN 952-462-128-2, print; ISBN 952-462-129-0, online. (TU)

9/2004 David G. Mayes – Matti Virén **Asymmetries in the Euro area economy.** 2004. 56 p. ISBN 952-462-130-4, print; ISBN 952-462-131-2, online. (TU)