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MONETARY AND EXCHANGE RATE POLICIES OF THE EURO AREA

Selected Issues

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Approved by the European I Department

October 3, 2002

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I. The Eurosystem's Definition of Price Stability[1]

A. Introduction

1. The Eurosystem's definition of price stability as an annual rate of increase in consumer prices of less than 2 percent, to be maintained over the medium term, has been criticized by outside observers on two counts. First, the definition has been portrayed as ambiguous and asymmetric, and less effective as an anchor for inflation expectations than a point inflation target (e.g. Svensson, 2002). Second, the 2 percent ceiling has been said to be too stringent to allow a smooth functioning of the euro economy and allow monetary policy to effectively pursue stabilization objectives in the face of large, adverse shocks (e.g., Begg et. al., 2002).

2. This paper reviews the ECB's definition of price stability from both angles. The first part of the paper examines whether the ECB's target definition is clear and symmetric and, to the extent that it is not, the paper discusses the relative benefits of "constructive ambiguity" versus increased specificity in the goal definition.

3. The second and more substantive part of the paper examines the factors determining "the optimal rate of inflation" in the euro area. It reviews the benefits of price stability, including the reduction in the distortions of savings and investment behavior that stem from the interaction between nominal tax systems and inflation. It then goes on to evaluate arguments for maintaining a small positive inflation rate in the context of the euro area, of which there are essentially three. First, due to various biases in the measurement of inflation, "true" inflation is likely to be lower than indicated by official price indices. Second, a small positive inflation rate may facilitate relative price and wage adjustment in an economy with downward nominal rigidities, i.e. in which there is resistance to price and especially wage cuts. In the case of the euro area, this issue has a particular dimension in that inflation may vary across member countries due to the gradual convergence in price levels, as well as the occasional need for relative wage adjustment among EMU members in response to country-specific shocks. Third, the closer the inflation goal is to zero, the higher the risk that monetary policy could be constrained by the inability of nominal interest rates to fall below zero if and when economy is hit by severe shocks.

4. The paper concludes that, although there may be benefits from adopting a point target for medium-term inflation, the arguments are finely balanced, and need to be weighed against the potential credibility cost of changing the objective. As for the level of inflation, a target toward the upper end of the ECB's price stability range would seem, at least with the current membership of EMU, to strike a judicious balance between reaping the benefits of price stability while allowing scope for inflation to assist relative price and wage adjustment across EMU and safeguard against deflation.

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[1] Prepared by Mads Kieler (mkieler@imf.org).

B. On the Clarity and Symmetry of the ECB's Inflation Objective

The ECB's objective of price stability and how it compares with others

5. The Treaty on European Union established "price stability" as the primary objective of the ESCB. As a secondary objective, the ESCB is required to support the general economic policies of the euro area with a view to contributing, inter alia, to high levels of employment and sustainable growth. Lawmakers refrained from specifying the price stability objective in operational terms or from delegating the authority to do so to any particular body. Consequently, it has been up to the ESCB itself to decide whether to provide a quantitative definition of price stability, and what such a definition should be. The Treaty mandate and the definition of price stability adopted by the Eurosystem are laid out in Box 1.

6. In providing a definition of price stability, the ECB has specified its medium-term inflation objective in more precise terms than some other central banks, such as the U.S. Federal Reserve or the Bank of Japan, which do not offer quantitative definitions of their targets. The reasons for doing so were manifold: the Treaty's emphasis on price stability made it natural to provide a definition that could guide policymaking, anchor inflation expectations, and facilitate the public's understanding of the aims and constraints of monetary policy. Moreover, a quantitative definition was seen as helpful in establishing the anti-inflation credentials of a new institution with literally no track record of its own.

7. On the other hand, the definition of price stability provides a less clear-cut demarcation of the ECB's inflation preferences than would an inflation target *per se*, for the following reasons:

- A definition of price stability is not the same as an inflation target or range. It does not follow from the definition of price stability that the ECB is indifferent between all inflation rates in the 0-2 percent range, or that it aims for the mid-point of that range; indeed, there are reasons to believe—and financial market participants appear to believe—that the ECB generally prefers medium-term inflation rates in the upper half of that range, i.e., in the 1-2 percent range;

- The ECB has noted that there might be measurement bias in the monetary union inflation index, and that the definition of price stability "allows for such bias by not setting the lower bound for measured price level increases at zero"; however, this makes the lower bound for measured inflation imprecise and potentially time-varying;

- The "medium term" horizon over which price stability is to be maintained is not specified.

Box 1. Price Stability: The ECB's Definition and its Antecedents

The Treaty on European Union states the objectives of the ECB in the following terms:

"The primary objective of the ESCB is to maintain price stability. Without prejudice to the objective of price stability the ESCB shall support the general economic policies of the Community with a view to contributing to the achievement of...a harmonious and balanced development of economic activities, sustainable and non-inflationary growth, ...[and] a high level of employment..." (Treaty on European Union, Articles 2 and 105).

The lexicographic ordering of objectives is not necessarily a reflection of legislators' and society's view of their relative importance. Rather, it reflects a consensus view of what monetary policy can be expected to deliver (low inflation) and what it cannot be expected to provide (full employment). The belief is also that central banks charged with delivering price stability are best placed to contribute effectively to output stability.

Taking its cue from the experience and practices of a number of participating central banks, as well as from the EU Council's prescription in successive Broad Economic Policy Guidelines, the ECB adopted the following definition:

"price stability shall be defined as a year-on-year increase in the Harmonized Index of Consumer Prices (HICP) for the euro area of below 2 percent." Price stability according to this definition "*is to be maintained over the medium term.*"

The ECB has since noted that the use of the word "increase" implied that deflation would not be deemed consistent with price stability.

The ECB also noted that there might be measurement bias in the HICP, and that this bias might vary over time. "*Therefore, the definition has avoided explicitly embodying specific estimates of the HICP measurement bias, while allowing for such bias by not setting the lower bound for measured price level increases at zero.*" Informally, ECB officials have, on occasion, interpreted the definition to mean measured inflation rates in the range [x-2] percent, where x is the (unknown) inflation measurement bias. The corresponding definition of price stability for "true" inflation would be [0-(2-x)] percent.

The most important antecedents to this definition were the practices of a number of EU central banks prior to EMU. The Bundesbank used a 2 percent "price norm" or "medium-term price assumption" in its calculation of target money growth for a number of years. During 1997 and 1998, this was lowered to 1.5–2 percent. Other participating central banks had also adopted inflation norms not exceeding 2 percent.

Language adopted by the Council of Ministers of Economic and Financial Affairs in the 1995 Broad Economic Policy Guidelines was also seen by the ECB to specify 2 percent as the maximum inflation rate compatible with price stability (see Issing et.al., 2001, p. 71.)

8. By way of comparison, some inflation targeting central banks have adopted point targets—e.g., 2 percent in Canada and Sweden and 2.5 percent in the United Kingdom[2]—while others have adopted target ranges (e.g., 2-3 percent in Australia and 0-3 percent in New Zealand). For those that have adopted ranges, the lower bound is explicit, and the mid-point of the range is generally taken to represent the preferred inflation outcome.

9. The policy horizon for most inflation-targeting central banks is specified at 1½-2 years, consistent with the lags with which monetary policy affects inflation and with the dying out of temporary and erratic price level shocks. (One exception is Australia, where the target is to be achieved over an unspecified business cycle.) The trend among both policymakers and academics has been to see real world inflation targeting as "flexible" rather than "strict" inflation targeting (in the terminology of Svensson, 1999). Flexible inflation targeting means that the central bank does not focus exclusively on the inflation forecast at some point in time but also has concern for the stability of the real economy. Among other things, this implies that inflation-targeting central banks aim to meet the inflation target further in the future when a large shock has moved inflation away from target.

Interpretations of the ECB's price stability objective

10. Observers have spent a fair amount of energy trying to deduce from the ECB's definition of price stability, as well as from ECB communications and actions, what level of inflation the ECB may "really" be targeting. Svensson, 1999 pointed out that the ECB's calculation of its reference value for M3 growth seemed consistent with inflation in the 1-2 percent range, the mid-point of which is 1½ percent. Others have noted that the mid-point of the Eurosystem's published inflation forecast ranges have also tended to be at 1½ percent towards the end of the projection horizon. Statements by ECB Board Member Issing at the 2002 ECB Watcher's Conference have also brought some clarification by recognizing that a small positive rate of inflation, "say between 1 and 2 percent" would significantly reduce the risks of getting trapped in a deflationary spiral, and stressing the need for vigilance were inflation to fall below 1 percent.

11. Although the ECB's preferences probably cannot be reduced to a time-invariant utility function in inflation, some stylized considerations may illustrate the extent to which the ECB's target is symmetric and well-defined. The top half of Figure 1 represents the ECB's utility function if and when the bank is indifferent between any medium-term inflation outcome in the price stability range (x-2 percent, where x is measurement bias). The

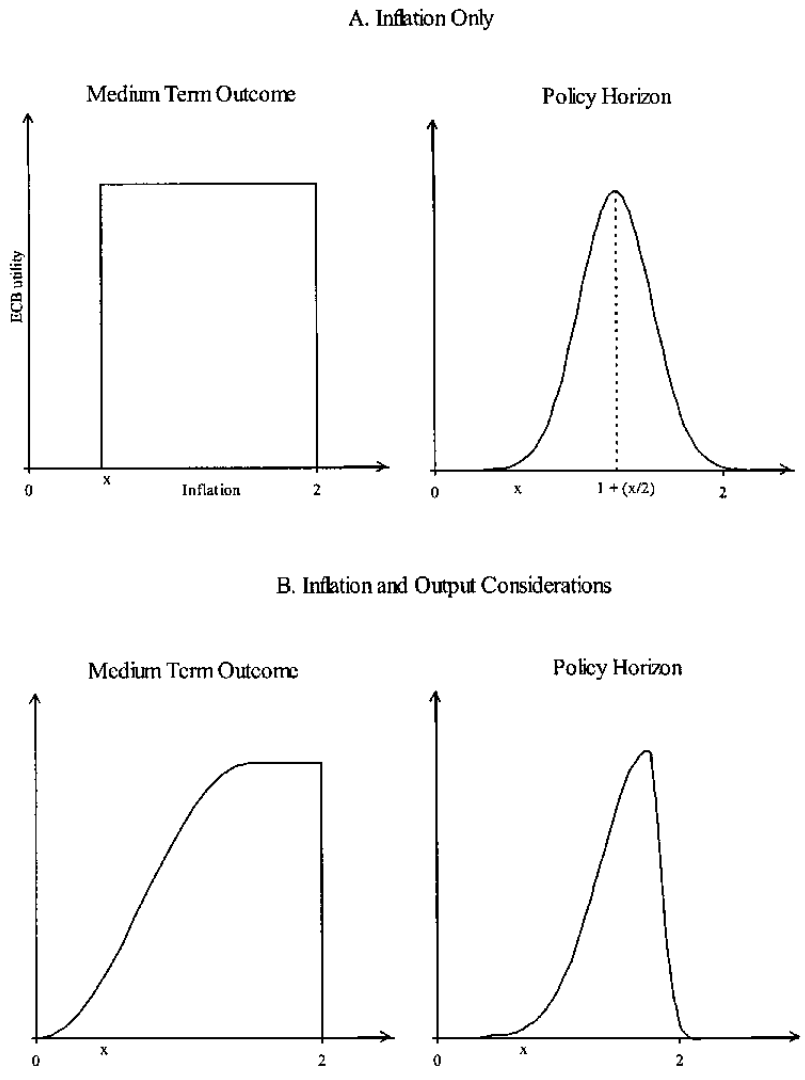
[2] The UK's target is specified in terms of the RPIX retail price index. Given methodological differences between this index and the EU-harmonized index of consumer prices (HICP), the target for RPIX may, on average over time, correspond to 2 percent (or less) for UK HICP.

bank will be indifferent between these outcomes if there is no trade-off between inflation and the level or variability of output (Section D discusses issues such as the zero interest rate floor and relative wage adjustment that may introduce such trade-offs at low inflation). At the relevant policy horizon, and assuming for illustrative purposes that the uncertainty surrounding the central inflation projection is symmetric, the bank's inflation target would be the mid-point of the *x*-2 percent range.

12. The lower half of Figure 1 depicts the situation if and when the bank perceives a tradeoff between inflation and the level or variability of output (e.g., if a small positive inflation rate facilitates relative price and wage adjustment, or if keeping some distance to zero inflation reduces the risk of deflation). Given the secondary objective of the ECB, the utility function would be tilted towards the upper end of the range defined as price stability. Over the policy horizon, a risk-conscious Governing Council would want to maintain a safety margin by aiming for an inflation forecast below 2 percent.

13. Although the definition of price stability is symmetric in a formal sense (0-2 percent), these factors imply some degree of asymmetry in practice, and it is difficult to know around which point exactly the ECB starts to worry about downside risks to price stability.

Figure 1. Interpretations of the ECB's Inflation Objective



14. Needless to say, these conjectures do not capture the full sophistication and complexity of the ECB's preferences—it is entirely possible that the ECB's inflation preferences at the policy horizon are in fact state dependent and time-varying.

Potential benefits of "constructive ambiguity"

15. There may be good reasons for not adopting an overly precise inflation target and policy horizon. After all, inflation-targeting is not the "only game in town", and there is still room for alternative monetary strategies and goal specifications.

16. Essentially two arguments have been forwarded by ECB officials for not providing an (even) more precise definition of the ECB's objectives:

- The economics profession has not come to an agreement on the optimal rate of inflation. In the words of Issing et. al. "*Both theoretical and practical arguments can be made in support of and against an inflation rate exactly equal to zero (possibly through a price level objective), or a small, but positive, rate of inflation... Given this situation, it could appear wise to refrain from the specification of an exact figure, let alone choose between zero and small positive inflation*" (Issing et.al., 2001, p. 69).

- The return to price stability after a shock should be gradual and depend on circumstances. A "*different policy response can be optimal depending on the initial conditions and the source and dimension of the exogenous shocks that cause deviations [of inflation] from the objective.*" Consequently, "*the central bank must be granted some room for maneuver*", for example in the interpretation of the nature of the shocks hitting the economy at a given point in time (Issing et. al., 2001, p. 69). For instance, the central bank may wish to raise real interest rates to prevent financial bubbles from gathering momentum, even if inflation is (temporarily) below its medium-term objective (e.g., the asset price bubble in Japan in the late 1980s and the recent high-tech bubble in United States emerged alongside low inflation).[3]

17. ECB officials have stressed that, on some of these points, similar conclusions appear to have been implicitly drawn for instance by the U.S. Federal Reserve. The Fed has striven to convey its anti-inflationary resolve without providing too precise quantitative definitions, and it retains a significant amount of discretion and policy flexibility in its response to shocks.

18. The ECB's definition also leaves open the possibility that policies may correct past over- or undershootings of the inflation target. (This contrasts with the traditional view of inflation targeting central banks as continually focusing on meeting the inflation target in the future while letting "bygones be bygones.") Provided the public knows that inflation overshoots will subsequently be corrected, an adverse price shock may be more easily absorbed if expectations of future inflation are lowered at the same time (e.g. Woodford, 1999). In a similar vein, some argue that targeting a price level path may help to stabilize

[3] Arguably, the Eurosystem could retain a considerable and desirable degree of discretion even with a specific inflation target by letting the policy time horizon remain unspecified.

output and prevent deflationary traps because inflation expectations are raised when prices fall (e.g., Svensson, 1999). However, the ECB has not indicated that it follows either of the two approaches.[4]

Potential costs of ambiguity

19. There are three potential costs associated with the ambiguity in the ECB's inflation goal, to do with policy setting, communication, and inflation expectations, respectively:

- First, the definition of price stability provides a less clear and less symmetric guide for policymakers than would a point target. Even when policymakers strive to be evenhanded there remains a risk that well-defined transgressions of price stability in the upward direction receive more focused attention than less clearly defined transgressions in the opposite direction.

- Second, the ambiguity may hamper understanding of the ECB's policies. For instance, it is unclear whether there is a zone of policy inaction when projected inflation is inside the price stability range. There is also uncertainty about what downside risks to price stability mean.

- Third, the ECB's definition arguably provides a less clear guide to inflation expectations than would a point target for inflation. A clear anchor for inflation expectations may improve the available trade-off between inflation and output variability, and it facilitates long-term contracting, saving and investment. In the context of wage negotiations, the starting point for inflation could vary more between the negotiating parties if the central bank has a somewhat vaguely defined objective than with a point target for inflation.

The experience of the first years

20. In view of inflation's persistent overshooting of the ECB's upper limit for price stability in the last couple of years the Eurosystem cannot be said to have been overly aggressive in pursuing price stability to the detriment of other considerations. The interest rate cuts in early 1999 and in 2001 demonstrated that the ECB was concerned about not letting the economy languish with inflation in the lower half of the price stability band. Although the Eurosystem has a track record of predictability that broadly compares with other major central banks, there are indications that markets were surprised about the timing of interest rate cuts in early 1999 and in 2001, see Chapter 3 of these Selected Issues.

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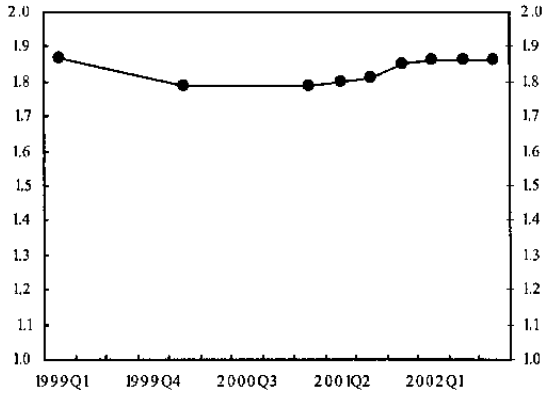
[4] Moreover, the distinction between inflation targeting and price level targeting may be somewhat artificial (King, 1999). Inflation-targeting central banks are ultimately likely to be held accountable against an average outturn for inflation over longer periods which would, in fact, be equivalent to price level targeting.

Uncertainty about the lower bound of the inflation objective may have contributed to difficulties in communication and understanding of ECB policies at the time, but so may other factors, including hard-to-interpret signals from the first pillar, above-target inflation in 2001, and the Governing Council's consensual approach to decision-making.

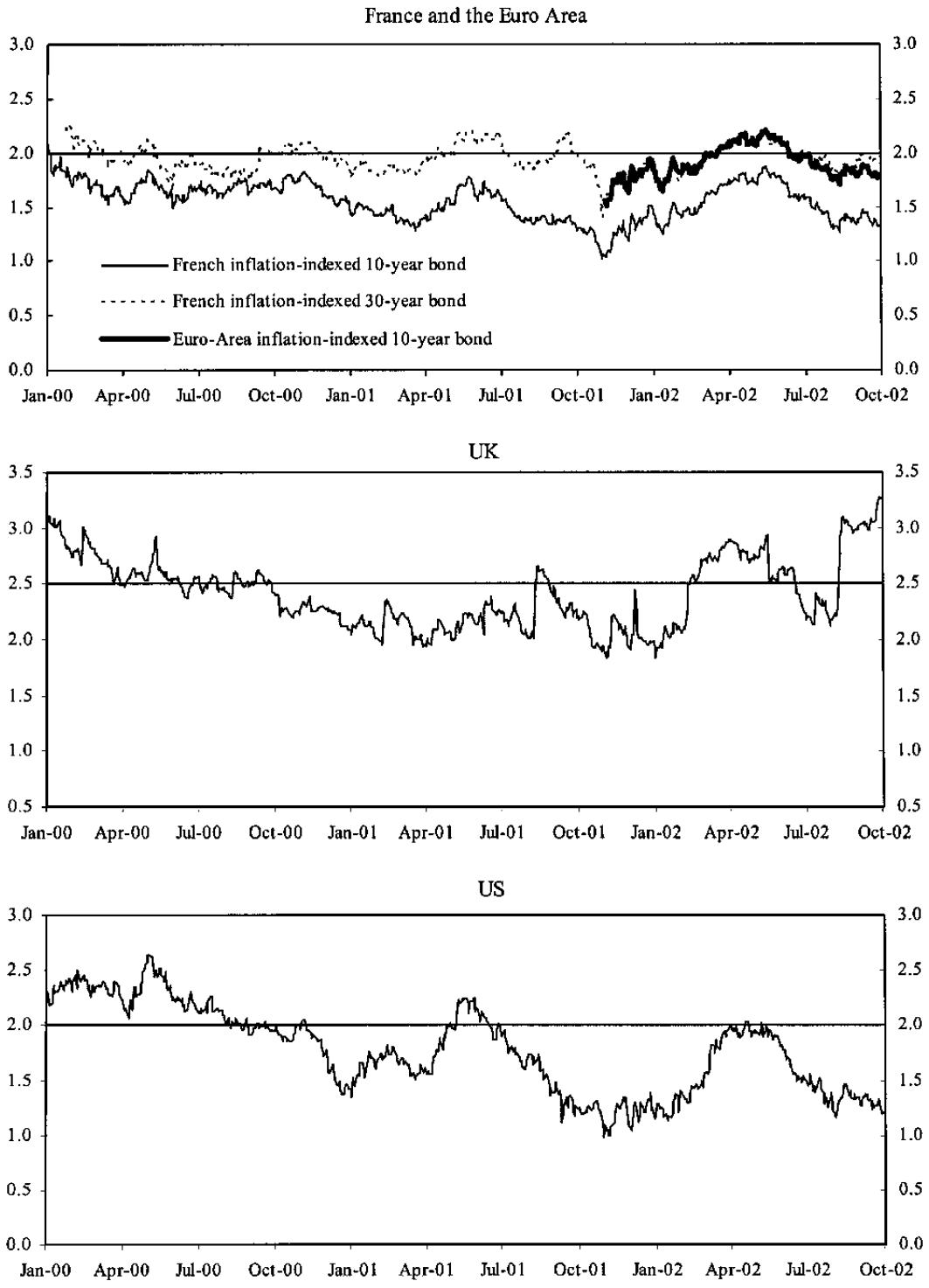
21. When it comes to guiding inflation expectations, surveys of professional forecasters suggest that expectations at the 5 year horizon have remained pinned down at 1.8-1.9 percent since the inception of EMU (Figure 2). Ten-year 'breakeven' inflation rates derived from index-linked and nominal bonds confirm that inflation expectations have generally stayed close to but below 2 percent (Figure 3, top panel). A temporary up tick above the 2 percent limit in the spring of 2002 occurred also in other countries and presumably reflected short-term financial premia unrelated to long-term inflation expectations. A comparison with other countries suggest that breakeven inflation expectations have been more stable in the euro area than in the United States, presumably by virtue of the quantitative definition of price stability (Figure 3). Long-term inflation expectations do not appear to have been less stable in the euro area than in the United Kingdom or Sweden (which have point inflation targets), although such comparisons are hampered by the different characteristics of the economies, and by shifting expectations that the United Kingdom or Sweden might join EMU and thus abandon their current targets within the ten-year horizon (evidence from financial market prices may also be distorted by liquidity and inflation risk premia). All told, although there is anecdotal evidence that short-term inflation expectations used in wage negotiations have shifted upwards to 2 percent following the recent overshoots of the ECB's inflation ceiling, long-term inflation expectations have been well anchored in the euro area. If, however, the ECB was aiming for 1½ percent inflation, as suggested by some, expectations have been less firmly on target than might have been the case.

Figure 2. Euro Area: Average Inflation Rates
Expected Five Years Ahead (Annual Percent Changes)



Source: ECB, surveys of professional forecasters.

Figure 3. Break-Even Inflation Rates in Selected Countries



Source: Bloomberg.

C. Benefits of Price Stability

22. We next turn to the issues involved in defining an appropriate or "optimal" rate of inflation to target over the medium term. Choosing a target rate of inflation involves difficult trade-offs between the "sand" and "grease" effects of inflation on the workings of the price mechanism, capital taxation, and the dangers of hitting the zero interest rate floor for monetary policy. Moreover, official inflation measures likely overstate "true" inflation by an unknown amount. Against this background, countries that have adopted explicit inflation targets have generally opted for small but positive inflation rates.[5] The remainder of this paper considers the relevant trade offs from the vantage point of the euro area.

23. The analysis is based on the premise that there are significant advantages of maintaining stable and low inflation ("low" taken to mean inflation rates below 2½-3 percent). The price mechanism works best at low inflation, thereby promoting a more efficient allocation of resources and higher output, and the long run Phillips curve is taken to be vertical for higher inflation rates. Following a long line of research which established that double-digit rates of inflation reduce economic growth (e.g., Fischer, 1993; Barro, 1995; Sarel, 1996), a study by Andres and Hernando, 1999 found that even moderate inflation had a sizeable and permanent negative effect on output by reducing investment and the efficiency with which factor inputs are used (however, since very few data points in the sample had inflation rates below 3 percent, the results could say very little about inflation below that level). Consequently, this paper is only concerned with the choice between different rates of low inflation.

24. Some of the most important benefits of low inflation have more to do with the *stability* of the inflation rate rather than the *level* of inflation *per se*. This holds notably with respect to the anchoring of inflation expectations and the functioning of the price mechanism. There is little to suggest that inflation would be more variable and that price and wage setters would be more liable to confuse general price movements with relative price changes if the inflation target was set at, say, 2 percent rather than 1 percent. Indeed, such "sand effects" of inflation on the working of the price mechanism might be more likely if the inflation target varies over time or is unclearly defined. By the same token, the macroeconomic benefits of a better anchoring of inflation expectations at low inflation stem from the priority accorded to price stability and the central bank's anti-inflation credentials (including its independence) rather than from the precise level of the target.

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[5] Arguably, the targets chosen by most inflation-targeting central banks are not very different from what has been suggested by prominent researchers. For instance, Summers, 1991 concluded that "the optimal rate of inflation is surely positive, perhaps as high as 2 or 3 percent", while Krugman, 1999 argued that the United States and Europe should set a target rate of "at least 2 percent".

25. Other traditional benefits of price stability—in terms of "shoe leather" and price adjustment (menu) costs—will vary only trivially among inflation rates inside or close to the ECB's definition of price stability.

26. A key benefit of price stability stems from the interaction of inflation with nominal tax systems, notably through taxation of the part of nominal returns on capital that compensate for inflation and tax deductibility of the same components of nominal interest expenditure. In most countries, this interaction means that higher inflation weakens incentives to save and induces overinvestment in housing. Reducing inflation would produce a permanent welfare gain through a better allocation of resources. Feldstein, 1997 found that the gain from price stability associated with the tax-inflation interaction is very large: going from 2 percent inflation to zero inflation in the U.S. would permanently raise welfare by an amount equal to about 1 percent of real GDP.

27. In a set of papers collected in Feldstein, 1999 similar methods were applied to Germany, Spain, and the United Kingdom. In the case of Germany, Tödter and Ziebarth, 1999 found that the gain from reducing inflation by 2 percentage points was equivalent to a perpetuity of 1.4 percent of GDP. The gain is somewhat larger than for the U.S. primarily because of the higher marginal rate of tax in Germany. For Spain, Dolado et. al. 1999 found an even larger gain (1.7 percent of GDP), principally because of the higher distortions in favor of housing demand. On the other hand, Bakhshi *et.al.,* 1999 found a much smaller gain in the case of Britain (0.2 percent of GDP), reflecting the ways in which U.K. taxpayers can reduce the tax on investment income and the limited tax advantage of home mortgages. Britain indexes capital gains for inflation and provides more opportunities for individuals to save in untaxed forms than do the other countries examined.

28. If these numbers are applied in an approximate fashion to the euro area, the perpetual gain from reducing inflation from 2 to 1 percent comes out roughly at 0.5 percent of GDP, the present value of which is 17 percent of GDP (discounted at a 3 percent real interest rate).

29. The most natural response to this distortion would be to change tax laws, and the incentive to do so would be considerable if the potential gains are as large as claimed. Feldstein 1997 lists some legal and administrative reasons why comprehensive tax indexing is, in his view, unlikely to be enacted and notes that full indexing has not been adopted by any major industrial country. On the other hand, the estimate for Britain suggests that changes in tax laws have the potential to massively reduce the distortions. Besides, doubts have been raised about the magnitude of the estimated benefits, and it has been argued that there may be a political economy equilibrium that determines the rate of capital income taxation and housing subsidization (Fischer, 1999). A reduction in effective capital taxation or mortgage subsidization induced by lower inflation could lead to offsetting changes in explicit tax rates on capital income and mortgage deductibility.

30. The benefits of zero inflation need to be weighed against possible downsides of maintaining inflation rates too close to that level. We turn next to the possible motives for maintaining a small positive inflation rate.

D. Benefits of Small Positive Inflation Rates

31. Maintaining a small positive inflation rate might be preferable to zero inflation on three principal counts. First, official measures of inflation likely overstate true inflation; second, inflation may help relative price and wage adjustment when the economy is beset by downward nominal rigidities; and third, countercyclical monetary policy action risks being constrained by the zero floor if inflation and nominal interest rates are kept too low in steady state. In the euro area, these issues are complicated by the fact that trend inflation may vary across countries and real exchange rates may need to adjust to country-specific shocks. Following a brief review of inflation measurement biases, this part draws together the empirical evidence on the likely divergence in trend inflation across EMU as a prelude to the analysis of relative price and wage adjustment. The last section examines the implications of the zero interest rate floor at low inflation rates.

Allowing for biases in inflation measurement

32. In the wake of the influential 1996 Boskin report on measurement biases in the U.S. CPI, several studies have tried to estimate the inflation measurement bias in European indices. These studies have generally found that the bias was lower than the Boskin estimates owing to a smaller "substitution bias" (Table 1). Lower substitution bias was due to more frequent updating of the weights than was the case in the U.S. at the time and differences in the detailed index calculation methods used.

33. Compared to the wealth of detailed price studies available for the U.S., however, the European results were based on very incomplete evidence as regards the "quality bias" which may arise from the inadequate adjustment of prices to take account of quality improvements. Even the Boskin report's estimates were subject to a large margin of uncertainty since quality biases are by nature hard to quantify. (As statisticians like to point out: if quality improvements were readily quantifiable, the indices would already be adjusted.) The less widespread use of hedonic price measures in Europe suggests that the quality bias could be higher than in the U.S. For example, the U.S. series for "personal computers and peripheral equipment" show a much more rapid price decline (roughly –30 percent per year since the introduction of hedonic prices in January 1998) than the euro area series for "information processing equipment" (–13 percent per year, and –20 percent in France which uses hedonic pricing).

Table 1. Estimates of the Measurement Bias
(percent)

	Total	Range
Germany	0.75	0.5-1.5
France 1/	-	> 0.1-0.25
United Kingdom	-	0.35-0.8
United States 2/	1.1	0.8-1.6
Canada	0.5	-

1/ Does not include 'quality bias.'
2/ Recent methodological changes have reduced the bias since Boskin's estimate.

Sources: Boskin, 1996; Cunningham, 1996; Hoffman,1998; Lequiller,1997; Crawford,1998.

34. On the other hand, the euro-area HICP does not presently include owner-occupied housing (an omission which is likely to reduce any overall bias), and recent research has found examples of potential downward biases in inflation measures, e.g. related to

difficulties in separating changes in "fashion" from quality (see references in Wynne and Rodriguez-Palenzuela, 2002).

35. A recent ECB working paper concluded that "there is very little scientific basis for putting a point estimate on the likely magnitude on the overall bias in the HICP." (Wynne and Rodriguez-Palenzuela, 2002). The paper also noted that the HICPs are work in progress, so measurement biases may change over time. An experimental index for owner-occupied housing is in the works with a view to possible later inclusion in the HICP on the basis of the net acquisition principle. Moreover, progress in harmonizing methods of quality adjustment across EU countries could also induce changes in the overall bias.

36. Even if a numerical assessment of the bias in the HICP remains elusive, however, a qualitative comparison with the well-researched CPI in the United States—on the basis of the studies of national CPIs quoted above and given that the national HICPs and CPIs mostly share the same detailed price information—would suggest that substitution biases are likely to be substantially lower than was the case for the U.S. CPI when the Boskin report was issued, while quality and possibly new product biases are likely to be at least as high in the euro-area HICP as in the U.S. owing to more extensive use of hedonic measures in the U.S. Consequently, measurement error may well account for a significant fraction of observed inflation in the euro area.

Allowing for cross-country variation in inflation

37. We next turn to the issue of judging the potential dispersion in trend inflation across EMU members owing to prospective price convergence. If some countries were to experience significantly below average inflation the smooth adjustment of relative wages and prices within and across countries might be stifled. The scope for steady-state inflation differences in EMU is assessed on the basis of three complementary approaches: applications of the Balassa-Samuelson model; examination of long-period real exchange rate trends; and an assessment of the pace of convergence in absolute price levels across EMU countries.

Balassa-Samuelson effects in EMU

38. The Balassa-Samuelson model explains real exchange rate movements in terms of sectoral productivity growth differentials, and rests on two components. First, the relative price of nontradables relative to tradables in each country reflects the relative productivity of labor in the traded and non-traded goods sectors. Second, the model assumes that purchasing power parity (PPP) holds for traded goods (in the long run). In EMU, this implies that price increases are equal across countries for traded goods, but that slower productivity growth in the non-traded goods sector makes for more rapid increases in unit labor costs and prices in that sector. National inflation differences will thus be determined by the cross-country variation in the sectoral productivity differentials and the weights of nontradables in national price indices.

39. Table 2 summarizes the results of several recent studies, realigned for comparability on an average trend inflation in the euro area of 1.5 percent, and assuming that sectoral

productivity differentials observed in the past will continue in the future. The results vary considerably depending on the sample, data, and methodology employed, and the most recent additions to the literature have significantly inflated the margin of uncertainty: Reuter and Sinn, 2000 provide much larger estimates of the dispersion than previous studies, while the opposite is the case for De Grauwe and Skudelny, 2000.

Table 2. Steady State Inflation Rates Implied by Balassa Samuelson Effects
(aligned to average Euro area inflation of 1.5 percent).

		Calculations based on:						
	Average of all columns	Alberola and Tyrväinen (1998)		Canzoneri et.al. (1998)		De Grauwe et.al. (2000)	Sinn and Reuter (2000)	HICP Proxy
Sample		1975 -1995	1985 -1995	1973 -1991	1973 -1997	1971 -1995	1987 -1995	1995 -2001
		------		value-added deflators			-------	CPI
Austria	1.6	1.3	1.0	1.7	1.3	2.0	2.0	2.0
Belgium	2.0	2.6	2.2	2.9	2.1	1.6	1.4	1.5
Finland	1.8	1.9	1.0	-	1.9	0.9	3.3	1.8
France	1.5	1.2	1.1	1.6	1.9	1.1	1.9	1.4
Germany	0.8	0.8	0.8	0.5	0.5	1.2	0.6	1.4
Greece	3.5	-	-	-	-	-	4.7	2.2
Ireland	2.9	-	-	-	-	-	2.9	2.9
Italy	2.0	1.9	1.9	2.5	2.3	1.9	2.1	1.4
Netherlands	1.7	1.8	1.6			1.5	2.0	1.8
Portugal	1.7	-	-	-	-	1.6	1.4	2.2
Spain	2.1	2.6	3.0	2.0	1.9	1.5	2.1	1.8
Euro area	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Max-Min	2.6	1.8	2.2	2.4	1.8	1.1	4.1	1.5
Dispersion	0.7	0.6	0.8	0.8	0.6	0.4	1.1	0.5

Source: author's calculations based on studies listed in the column headings.

40. Taken at face value, the results suggest that steady state inflation in Germany could be significantly below the euro area average, and perhaps below 1 percent if the ECB aims for 1.5 percent for the aggregate. Catching-up countries generally would register higher-than-average inflation rates although the results are more divided in this respect than one might have expected. Most of the remaining countries would be close to the average.

41. Also of interest are the underlying differences across sectors. The average productivity growth differential between the tradables and nontradables sectors in the euro area has been 1¾ percent per year, and the average inflation rate for nontradables have exceeded that of tradables by the same amount. Given their respective weights in GDP, average trend inflation of 1.5 percent in the euro area would imply trend inflation for tradables as low as 0.3 percent, and 2.0 percent for services (value-added deflators). The trend inflation for goods retail prices would be around ¾ percent owing to the retail and distribution components of their final sales prices.

42. Despite its intellectual attraction, the Balassa-Samuelson model has not received unequivocal backing in the empirical literature. Most studies do find that relative prices generally reflect relative labor productivities in the long run (and in some empirical applications, relative wages), but the evidence on purchasing power parity in traded goods is less favorable (see Canzoneri et.al., 1999). As to whether the Balassa-Samuelson model or PPP for broad price measures provides the best description of long-run real exchange rate movements, Rogoff, 1996 concluded that:

"Overall, there is substantial empirical support for the Balassa-Samuelson hypothesis, especially in comparisons between very poor and very rich countries, and in time series data for a select number of countries, including especially Japan. Whether [it] is of broader importance in explaining real exchange rates across industrialized countries is a matter of some debate. We have already seen that a substantial body of evidence suggest that across industrialized countries, there is long-run convergence to PPP, the Balassa-Samuelson effect notwithstanding" (Rogoff 1996, p. 662).

43. There are several reasons to believe that the above quantifications of the Balassa-Samuelson effect may overestimate the extent of likely inflation divergences in EMU:

- Fast productivity growth in the traded-goods sectors in catching-up countries owes, at least in part, to rising capital-labor ratios. Consequently, total costs per unit and thus prices may diverge less between sectors than unit labor costs alone would indicate;[6]

- The value-added deflator in the tradables sector may not be an adequate measure of the price of domestically produced tradables; in fact, input-output data show that domestic non-traded goods sectors provide substantial inputs to the tradables sector;

- Different sector productivity trends owe in part to shifts in the composition of labor (e.g. towards more use of low-skill and part-time employment in services relative to manufacturing) which may equally affect service sector wages. Such productivity changes would have little impact on unit labor costs and relative prices. (Alberola and Tyrväinen, 1998 are among the few to control for sectoral wage differences).

44. The HICP proxy in the right-hand column of Table 2 is calculated by assuming that the trend differential between industrial goods (excluding energy) and services in each country's HICP remains constant going forward. This simple proxy is immune to the criticisms above since it relies directly on observed inflation differentials, not productivity differentials, and because PPP may be a more appropriate assumption for the consumer basket of tradables (which includes a mix of foreign and domestic goods) than the value-added deflator (which covers only domestic goods). This proxy shows an inflation range in EMU from 1.4 percent in France and Germany to 2.9 percent in Ireland.

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[6] In theory, the Balassa-Samuelson effect is driven by sectoral differences in TFP growth (see e.g. the presentation in Froot and Rogoff, 1995). However, most empirical applications focus on labor productivity. An exception is Swagel, 2002.

Extrapolating past real exchange rate trends

45. If money is neutral in the long run, real exchange rates movements should ultimately be determined by factors in the real economy. Consequently, the fact that EMU countries used to have separate currencies should not be a prime determinant of past long-period real exchange rate trends, and the latter may therefore provide pointers to what could be in store in EMU. This approach imposes much less structure than the Balassa-Samuelson model, and largely leaves open what factors explained past trends. On one level this is an advantage because it allows for an unrestricted array of determinants of real exchange rate movements. On another level it is a drawback, because in the absence of specific hypotheses of what drives real exchange rates, it is hard to assess whether and to what extent they are likely to continue in EMU.

Figure 4. Euro Countries: Consumer Prices Relative to Germany, 1960-2001.

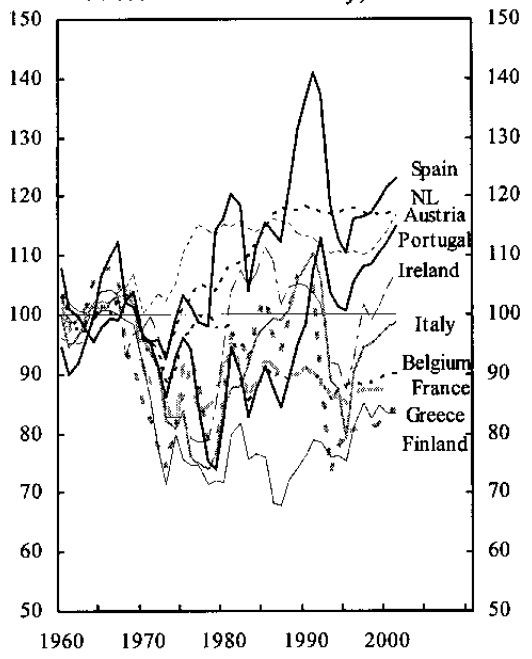

Table 3. Steady State Inflation Based on Extrapolation of Real Exchange Rate Trends

	Consumer prices 1/			GDP deflator
	1961-2001	1975-2001	1985-2001	1975-2001
Austria	1.9	2.1	1.9	1.7
Belgium	1.2	1.2	1.1	1.5
Finland	1.0	1.4	1.2	0.3
France	1.1	1.3	1.1	1.1
Germany	1.5	1.4	1.3	1.5
Greece	0.9	1.1	1.7	2.1
Ireland	1.6	1.7	2.3	1.3
Italy	1.5	1.5	2.0	1.6
Luxembourg	1.1	1.4	1.5	1.9
Netherlands	2.0	1.9	1.5	1.6
Portugal	1.7	2.0	2.0	3.0
Spain	2.2	2.2	2.0	1.9
Euro area	1.5	1.5	1.5	1.5
Max-min	1.4	1.1	1.2	2.7
Dispersion	0.5	0.4	0.4	0.6

1/ Deflator of private consumption.
Source: EU Commission, and own calculations.

Figure 4 shows the movements in EMU countries' price levels relative to Germany since 1960 when measured in common currency; and Table 3 shows implied steady state inflation rates in EMU based on extrapolations of past relative price adjustments.

46. These calculations suggest that the scope for inflation differentials in EMU is smaller than Balassa-Samuelson calculations imply (especially bearing in mind the absence of data for Portugal, Ireland, and Greece in most studies reported in Table 2). Nonetheless, they do not rule out that trend inflation could be around 1 percent in one or more countries if the euro area average were to be maintained at 1.5 percent.

Convergence in absolute price levels

47. However, income convergence has progressed across the EU during recent decades and real exchange rate appreciation for lower-income countries may therefore be smaller going forward than in historical samples.

48. Absolute price levels vary across the EU in a manner that relates fairly closely to relative living standards (Figure 5). The correlation coefficient between absolute 1999 price levels and per capita income is 0.68. Correcting for differences in indirect taxes the correlation was 0.83 in 1996, the latest year for which price data excluding taxes are available.

Figure 5. EU Countries: Price Levels and GDP per Capita, 1999
(indices; euro area=100)

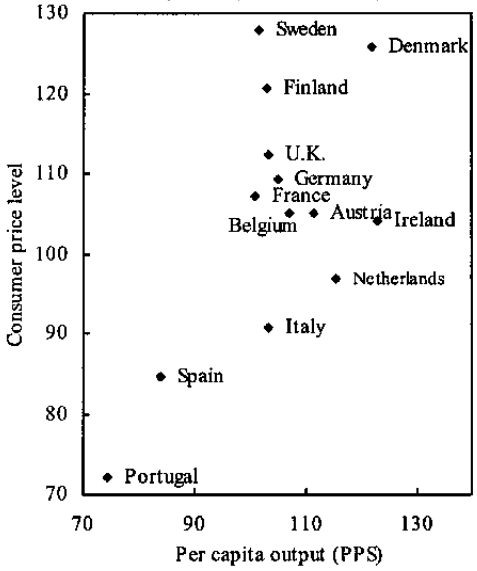

Table 4. EU Countries: Price Levels Compared
(1999; index EU12=100)

	Goods			Services		
	Core goods 1/	Food, tobacco	Energy	Core services 2/	Commu-nications	Rents
Austria	99	104	102	107	128	81
Belgium	100	101	95	102	113	87
Finland	117	109	83	102	85	93
France	106	110	103	107	96	101
Germany	99	102	108	109	111	112
Greece	108	88	65	52	72	60
Ireland	99	97	86	89	108	65
Italy	97	102	96	85	87	54
Netherland	97	94	91	94	89	104
Portugal	97	80	102	64	103	31
Spain	95	83	74	83	83	57
Euro area	100	100	100	100	100	100
Denmark	124	134	155	112	79	84
Sweden	105	114	94	121	94	105
U.K.	94	101	87	103	105	78

Source: Eurostat, and own calculations. Provisional data.

49. Table 4 breaks down the overall price levels in terms of six goods and services categories. As is evident from column 1, the price levels of 'core' goods (which excludes food, alcohol and tobacco) are very similar across EMU, indicating highly integrated markets: the only significant outliers are geographically isolated Finland and Greece. The degree of price convergence appears almost surprisingly large, given the relatively high share in retail prices of domestic inputs (retail, distribution and indirect taxes). However, cheaper labor and land inputs in the distribution sectors of lower-income countries are seemingly off-set by lower efficiency, possibly related to high numbers of small-scale outlets. Moreover, cross-border shopping provides for arbitrage at the retail level, particularly among neighboring countries (although prices do vary considerably for many individual subcomponents of 'core goods').

50. By contrast, services prices vary widely across countries, and there is a clear tendency for prices to be lower in the relatively poorer countries. The prospective convergence in price levels as these economies catch up with the more advanced economies will necessarily imply divergence in inflation rates. Another way of expressing the same point is that convergence on absolute PPP necessitates temporary deviations from relative PPP.

51. Table 5 provides some illustrative calculations of how average inflation rates might differ across the euro area over the next 10-20 years, depending on the how fast the remaining differences in price levels are reduced. This exercise should be taken with a grain of salt—for instance, it is possible that geographically remote Finland could maintain high indirect taxes and retail prices despite intensified pressures for harmonization. Nonetheless, the results are broadly corroborative of the previous approach and lends support to the notion that trend inflation rates could vary from around 1-1¼ percent in Germany and France to 2-3¼ percent in Portugal, Greece, and Spain.

Table 5. Steady State Inflation Rates Based on Convergence in Price Levels
(aligned to 1.5 percent for the euro area)

	Half-life (years)		
	10	15	20
Austria	1.3	1.3	1.4
Belgium	1.3	1.3	1.4
Finland	0.6	0.9	1.1
France	1.2	1.3	1.3
Germany	1.1	1.2	1.3
Greece	2.6	2.2	2.0
Ireland	1.3	1.4	1.4
Italy	2.0	1.8	1.7
Netherlands	1.7	1.6	1.6
Portugal	3.3	2.7	2.4
Spain	2.4	2.1	1.9
Euro area	1.5	1.5	1.5
Max-min	2.7	1.8	1.3
St.dev.	0.8	0.5	0.4

Source: Eurostat, and own calculations.

52. For a broad sample of countries, Barro and Sala-î-Martin, 1995 estimate that relative differences in per capita incomes are reduced on average by 3 percent per annum. Using different estimation methods, Björksten, 2000 finds convergence to be more rapid. Applying the range of estimates in the EU context implies that lower income Portugal and Greece should enjoy productivity growth of about 1-1½ percent higher per year than the highest income countries, in which case the half-life of remaining output (and price level) differences would be 15-20 years.

53. Experience from actual monetary unions may also shed light on the issue of inflation differences in EMU. In the monetary union between Ireland and the U.K.—countries with a considerable disparity in economic development—the average difference in annual inflation was a moderate 0.4 percentage points between 1950 and 1978. Between Luxembourg and Belgium, there was no difference on average over the 1950-2001 period.

Implications of enlargement

54. Any enlargement of EMU to include wealthy EU members Denmark, Sweden, and the United Kingdom seems unlikely to broaden the scope for inflation divergence significantly, although pressures for absolute price convergence could keep inflation below average in high-price Sweden and Denmark. However, the EU is conducting enlargement negotiations with ten eastern European countries as well as Cyprus and Malta. Turkey has also applied for membership. The EU aims to conclude the negotiations with those countries that are ready to join by the end of 2002 so that they can accede by 2004, and several others are expected to follow not long thereafter. Some of them seem keen on joining EMU at the

earliest opportunity, which could be by 2006 provided they fulfill the Treaty's convergence criteria.

55. In 1998, the combined GDP of the EU applicant countries amounted to no more than 9 percent of euro area GDP, less than Spain alone (Björksten, 2000). One might therefore surmise that the effect of above-average inflation in the newcomers would have a limited effect on the aggregate. The results in Sinn and Reutter, 2000 imply that 1.5 percent steady state inflation in an enlarged euro area of 21 countries (namely the current 15 EU members plus Poland, Hungary, the Czech Republic, Estonia, Slovenia, and Turkey, but omitting Cyprus, Bulgaria, Romania, Lithuania, Latvia, Malta, and the Slovak Republic due to lack of data) would require a reduction in trend inflation for the existing euro area countries of 0.2 percentage points. While the calculations are based on very short samples, the implied steady state inflation rates for most newcomers would be in range of 3-4½ percent, which is consistent with the estimates in Halpern and Wyplosz, 2001. The latter conclude that inflation rates in Poland, Hungary, the Czech Republic, Slovenia, Latvia, and Romania could be some 3 percent above that in the euro area.

56. However, as real convergence progresses, the weight in the euro aggregates of accession countries would converge on their share in euro area population, which could be as high as one third of an enlarged euro area. To be sure, the speed of convergence and size of the inflation differential would decrease as states neared the advanced-country technology frontier. Björksten, 2000 conducted a simulation in which he assumed: (i) 13 applicant countries joining EMU within 15 years; (ii) average real GDP growth of 2 percent in wealthier countries, (iii) average real growth of 5 percent per year in accession countries until 2010, subsiding thereafter, and (iv) average inflation of 5 percent until 2010, 4 percent during 2010-15, and 3 percent thereafter. If the accession countries all joined the euro, the current members would be obliged to maintain average annual inflation levels below 1¼ percent in order to keep area-wide inflation below 2 percent (and below ¾ percent to keep the area-wide rate below 1.5 percent). After 20 years of convergence, per capita GDP in accession countries would still only be about two thirds of the euro area average, so price convergence could go on for some time after that, even if at a reduced pace.

57. The prospect of enlargement strongly underlines the need for the Eurosystem's target for inflation to allow scope for variation in trend inflation across countries.[7] Variation in trend inflation rates—while probably not as large with the current country composition as suggested by applications of the Balassa-Samuelson model—may affect the smooth functioning of EMU if nominal rigidities hamper price and wage adjustment at near-zero inflation. It is to this issue that we turn next.

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[7] It also implies that premature EMU participation would make it difficult for low-income countries to maintain domestic price stability, and their early participation in conjunction with an unchanged definition of price stability for the area as a whole could raise difficulties for economic policy management.

Inflation as a lubricant in price and wage adjustment

58. The idea that a moderate level of inflation may "grease the wheels" of relative price and wage adjustment in an economy where agents are averse to nominal wage or price cuts was revived in the 1990s as inflation rates returned to low levels.[8] Downward rigidities may stem from elements of money illusion, entrenched perceptions about "fairness", and employer concerns about the impact of wage cuts on worker morale. A seminal paper by Akerlof, Dickens and Perry 1996 argued that steady-state unemployment (in the U.S.) would be higher at rates of inflation below 3 percent, and especially below 2 percent. On the other hand, the coexistence of low inflation and falling NAIRUs in a number of industrialized economies in the 1990s—including the U.S., the U.K., and several euro countries—suggests that the reduction in inflation to roughly 2 percent has not had any detrimental impact on the smooth functioning of labor markets. The issue is briefly explored below for product markets, and at greater length for wages.

Product markets

59. Evidence from euro-area price indices suggests nominal price cuts are not as uncommon as is often believed. For instance, the fraction of the euro area HICP that displayed negative year-on-year inflation rates in March 2002 (when headline inflation was 2.5 percent) was 11 percent. In December 1998, when inflation 0.8 percent, one fifth of all categories exhibited negative inflation.

60. If goods and services markets were characterized by downward nominal rigidities, one would expect the distribution of price changes to alter shape and exhibit more zero changes as the inflation rate falls. Figure 6 shows the distribution of year on year price changes in the HICP at six discrete points in time, and reveals no obvious signs that the distribution is affected by the median inflation rate. Figure 7 charts the median and the skewness of the distribution since 1990 (upper panel), and a cross-plot of the median vs. skewness (lower panel). There is little to suggest that lower inflation in the euro area has affected the skewness of the distribution, as would have been expected in the presence of downward rigidities.[9] (Similar conclusions were reached for the United Kingdom by Yates, 1998 and King, 1999).

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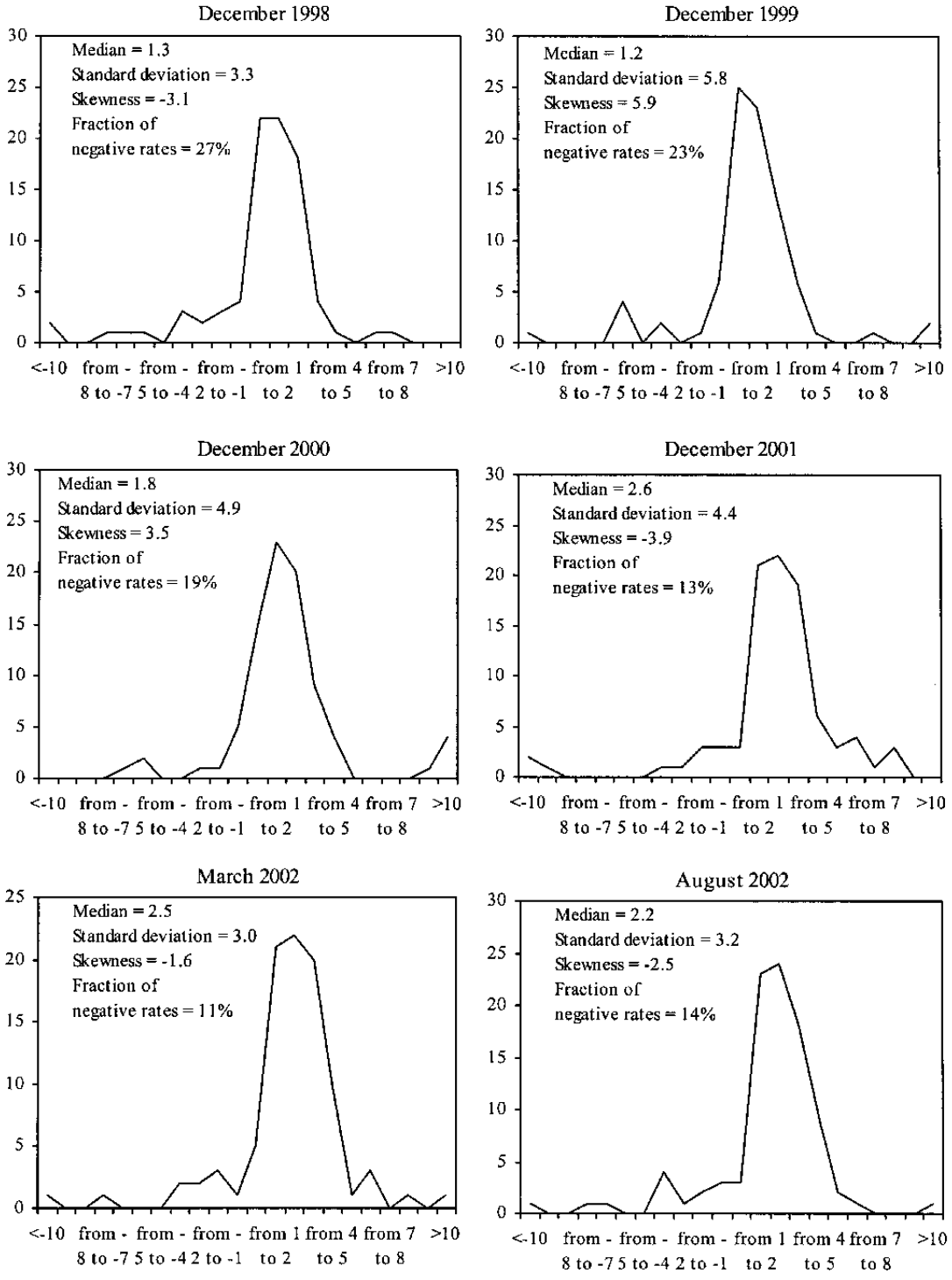
[8] The issue goes back at least as far as Keynes' "General Theory", 1936, and was prominent in Tobin's 1971 AEA address.

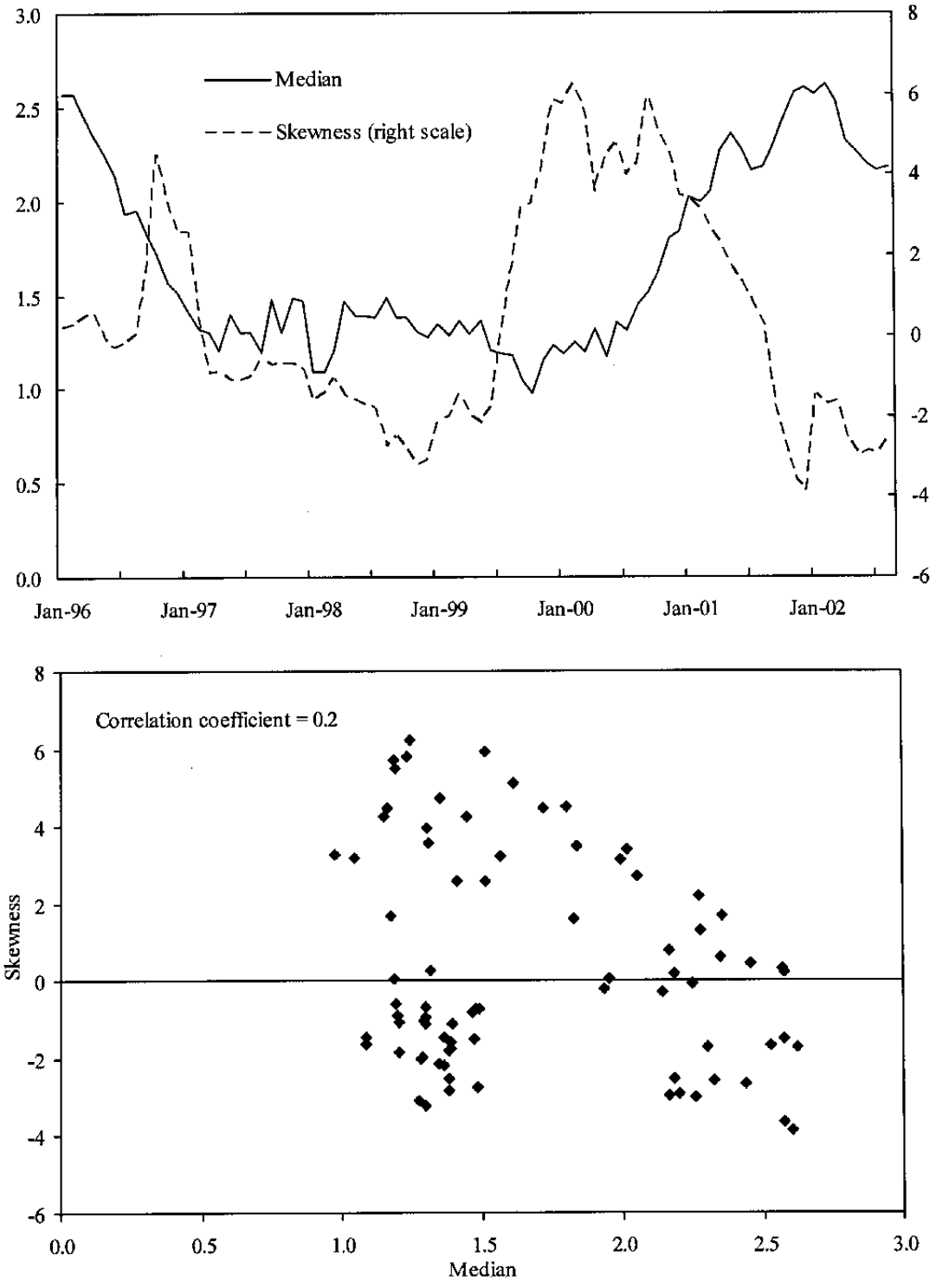
[9] On price rigidities, see also Yates, 1998, and Blinder, 1994.

Figure 6. Euro Area: Distribution of Annual Price Changes Among CPI Components



Sources: Eurostat; and staff estimates.

Figure 7. Euro Area: Median and Skewness of the Distribution of Price Changes



Source: Eurostat.

Labor markets: downward nominal wage rigidity

61. While not conclusive, the cumulated evidence on downward nominal wage rigidities (Box 2) points to such rigidities being quite pervasive in the primary sector of the labor market in industrial countries, in the sense that cuts in base pay for given worker effort are much more rare than if there were no nominal rigidity. Out of concern for worker morale, wage cuts are enacted almost exclusively in conditions of severe distress (Bewley 1999). At the same time, however, variations in hours worked and bonuses provide substantial flexibility in companies' wage bill. Moreover, the secondary sector of the labor market, where turnover is high and part-time and temporary jobs are common, exhibit much more flexibility in nominal wages than does the primary sector (Bewley 1999).

62. Much less is known about the effects of downward nominal wage rigidity for aggregate employment and wage outcomes. Akerlof, Dickens and Perry 1996 used a simulation model of the U.S. economy—in which a random distribution of wage changes across employers was truncated so that firms cut back employment instead of cutting wages for workers whose marginal revenue product had fallen—to argue that steady-state unemployment is higher at very low rates of inflation. Their results suggest that average inflation of 2 percent in the U.S. would result in a permanent increase in unemployment of around 0.2 percentage points compared to the natural rate of unemployment obtaining at inflation rates of 3 percent or more. An inflation target of 1 percent would add an additional ½ percentage point to the steady-state unemployment rate.[10] On the other hand, Groshen and Schweitzer 1999—who take account not only of inflation's "grease" effects in aiding relative wage adjustment but also its "sand effects" in distorting price signals—found little or no increase in unemployment at low inflation rates. Using a high-quality establishment data set they established that modest inflation has a positive but small and statistically insignificant impact on the labor market, but that sand effects exceed grease effects at inflation rates over 5 percent.

63. In judging the importance of this issue for the euro area, questions arise as to the extent to which U.S. considerations apply to Europe, given the very different labor market institutions in place there. It is widely accepted that *real,* not nominal, wages are more rigid in Europe than in the United States, even if such rigidities relaxed in the 1990s. In the euro area, there is little to suggest that wages adjust quickly to local or occupational supply and demand conditions in the manner of the U.S. labor market (see, e.g., Prasad, 1999 on "the unbearable stability of the German wage structure"). If relative wage rigidity largely reflects wage-setting institutions and the impact of government regulations, inflation above a certain level is unlikely to do much to speed up wage adjustment.

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[10] In a subsequent paper, Akerlof, Dickens, and Perry, 2000, argue that unemployment might be *lower* at very low inflation than at higher inflation rates because some agents are fooled by a small positive inflation to offer more labor than they would in the absence of money illusion. That equilibrium would not, however, be optimal and probably not sustainable.

Box 2: Evidence on Downward Nominal Wage Rigidities

The clearest evidence of downward wage rigidities come from studies that rely on firm-specific, contract, or interview data and focus on base pay rates in the primary sector of the labor market. Using ***firm-specific data***, Wilson 1999 found 0.1 percent and 0.0 percent of jobstayers suffered wage cuts in two large U.S. service sector firms; Fehr and Goette 2000 found wage cuts in 1.7 percent and 0.4 percent of cases in two large Swiss firms; and Altonji and Devereux, 1999 found that only 0.5 percent of salaried workers and 2.5 percent of hourly workers received wage reductions in a large U.S. financial corporation, almost all of which were associated with changes in part time/full time status or performance-related incentives. There is no guarantee that these firms are representative, but the presumption that they may well be so is bolstered by extensive ***interview studies of employers*** (notably Bewley, 1999, but also Shafir, Diamond, and Tversky 1997; Blinder and Don Choi 1990; Agell and Lundborg 1995) which without exception confirm that wage cuts are uncommon. Bewley, however, reports that wage flexibility is much more pronounced in the secondary sector of the labor market for part-time and temporary jobs. Finally, Akerlof, et. al., 1996 found negative pay changes in about 2 percent of cases in ***telephone surveys,*** and Fortin 1996 and others confirm that negotiated wage cuts are rare in ***contract settlements***.

A growing number of papers have examined the existence of downward nominal wage rigidities using ***household panel data*** (including for the U.S. Kahn, 1997 and Card and Hyslop, 1996; for the U.K. Smith, 2000; and for Germany Decressin and Decressin, 2002) or ***employer-supplied data*** (e.g. Groshen and Schweitzer, 1999 and Lebow et.al. 1999 for U.S. establishment data; Nickell and Quintini, 2001 for the UK; and Beissinger and Knoppik, 2001 for German social security data). These studies generally find some bunching of wage changes around the zero mark for workers who stay in a given job in a manner consistent with downward nominal rigidity. (They also indicate that surprisingly high numbers of wage earners suffer nominal wage cuts in an average year (spanning 15-25 percent of non-job changers) which may owe much to the inclusion of overtime pay, bonuses, and other flexible elements (e.g. night shifts, perks) in the measure of remunerations, as well as to reporting errors.)[1]

For the purposes of this paper, the most important aspect of these studies concerns the tests performed of how the wage change distribution is affected by the level of inflation (as argued in Decressin and Decressin 2002, reporting error lowers the power of such tests but does not invalidate them). The tests carried out for the euro area's largest economy by Beissinger and Knoppik 2001 and Decressin and Decressin 2002 find that the level of inflation affects the distribution of wage changes. The zero mark is binding more often at very low inflation rates so that real wage adjustments could be hampered in Germany. (Similar results were found for the UK by Nickell and Quintini; for the U.S., Groshen and Schweitzer, 1999 pinpoint declining grease effects during low inflation periods). Decressin and Decressin 2002 judge the effect to be too small to make a compelling case for the ECB to adopt a higher inflation target but also note that the presence of a nominal rigidity at the zero mark for base wages suggests pushing inflation much below 2 percent could bear risks. Based on similar analyses Beissinger and Knoppik suggest the ECB should aim at the upper bound of its target.

[1] For the U.S., there is some direct evidence of such errors: a validation study of the Panel Study of Income Dynamics (PSID) suggested only 44.2 percent of respondents reported their wage correctly, and the standard deviation between the log wages of the survey responses and the actual wages (as measured by establishment data) was 16.7 percent (discussed in Akerlof et.al. 1996, p. 13). In a similar vein, Shea 1997 noted that in a sample of workers of which only 1.3 percent received actual wage cuts, 21 percent reported cuts in the household survey.

64. Moreover, bearing in mind the effects of productivity growth, relative wage growth can vary significantly across workers even at low inflation rates. If average long-term hourly wage growth in the area was 3½-4 percent, consistent with average hourly productivity growth of 1½-2 percent and trend inflation just below 2 percent, relative wages across occupations could in principle vary to the tune of, say, 7-8 percent a year, if some workers got zero increases, and others were at the top of a broadly symmetric distribution (Svensson, 2000). Considering how slowly the wage structure in most European countries has responded to differences in unemployment rates across skill levels and regions, inflation rates of 1½-2 percent would not seem to constitute an obstacle to efficient relative wage changes within countries (even if some of them may experience slightly below-average trend inflation). This view is in line with the studies of the interaction of inflation with nominal wage rigidities quoted in Box 2.

Aggregate wage flexibility

65. An additional dimension arises because of the occasional need for relative wage adjustment among EMU countries in response to asymmetric (country-specific) shocks.

66. Nominal wage rigidities may give rise to non-linearities in Phillips curve relationships at low inflation, whereby the money wage responds more to a positive shock to labor demand than to a negative shock of equal magnitude.[11] Price rigidities of the "menu cost" or "staggered contracts" types may also flatten the slope of the short-run Phillips curve at low inflation rates, implying that a larger shift in unemployment produces a smaller change in the rate of inflation. (Ball, Mankiw, and Romer, 1988 showed that less frequent price adjustments in a regime of low steady state inflation flattens the slope of the short-run output inflation trade off; for a more recent application see Begg et.al.2002).

67. The weight of the evidence is suggestive of non-linearities in the Phillips curve. Laxton *et.al.*, 1995 find that the inflation-output trade-off is non-linear in pooled data from the G7 countries. In contrast, Turner, 1995 finds that the Phillips curve is linear in the euro-area countries studied, and non-linear in only three OECD economies, namely the United States, Japan, and Canada. As Laxton et.al. 1997 note, however, standard tests will be biased toward the linear model. Pyyhtiä, 1999 find strong evidence of nonlinearity in the Phillips curves of many euro countries, and that the deflationary impact of a negative output gap is very small and not significant as a rule. According to his results, the Phillips curve has been especially asymmetric in Germany, Italy, Spain, the Netherlands, and Finland.

68. At the level of individual euro countries, the issue is whether low inflation among euro partners will prolong the time it takes to regain competitiveness following an adverse

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[11] The short-run Phillips curve may be non-linear also at higher inflation rates in the presence of so-called *real* rigidities, e.g. if workers resist reductions in the rate of wage increase relative to others.

shock. This may be illustrated using a simple example: suppose that a country needs to improve its competitiveness relative to euro area partners by 10 percent, and that trend inflation in the area were at 2 percent while trend productivity per hour is also 2 percent. In that case, hourly wages may grow at a trend rate of 4 percent per year for the area as a whole. If our hypothetical country managed to keep wage growth at zero (and productivity growth was unaffected), it could restore its competitiveness within two and a half years. If, however, the downward nominal rigidity is such as to make it difficult to reduce average nominal wage growth below, say, 2 percent, then regaining competitiveness would take five years.[12] If the average inflation target was, say, 1 percent it would take longer to restore competitiveness and profitability, namely 3-3½ years with zero wage growth, and 7 years if wage growth could not be reduced below, say, 1½ percent.

69. An example of how this type of process works in practice is given by Germany's adjustment relative to euro-area partners in the first three years of EMU's existence (Table 6). Germany managed to keep annual unit labor cost growth some 1½ percent below its partners, gaining competitiveness to the tune of 4 percent over three years, in an environment of 2 percent average inflation.

Table 6. Relative Wage Adjustment Within EMU, 1999-2001 (annual average growth; percent)

	Germany	Rest of Area	Diffe-rential	Euro Area
Hourly wages, industry 1/	3.0	3.3	0.3	3.2
Compensation per head 2/	1.3	3.2	1.9	2.6
Unit labor costs	0.8	2.2	1.4	1.7
Real unit labour costs	0.1	-0.2	-0.3	-0.1
GDP deflator	0.7	2.3	1.6	1.8
Private consumption deflator	1.4	2.3	0.9	2.0

1/ Hourly compensation in manufacturing.
2/ Nominal compensation per employee; total economy.
Source: European Commission, and staff calculations.

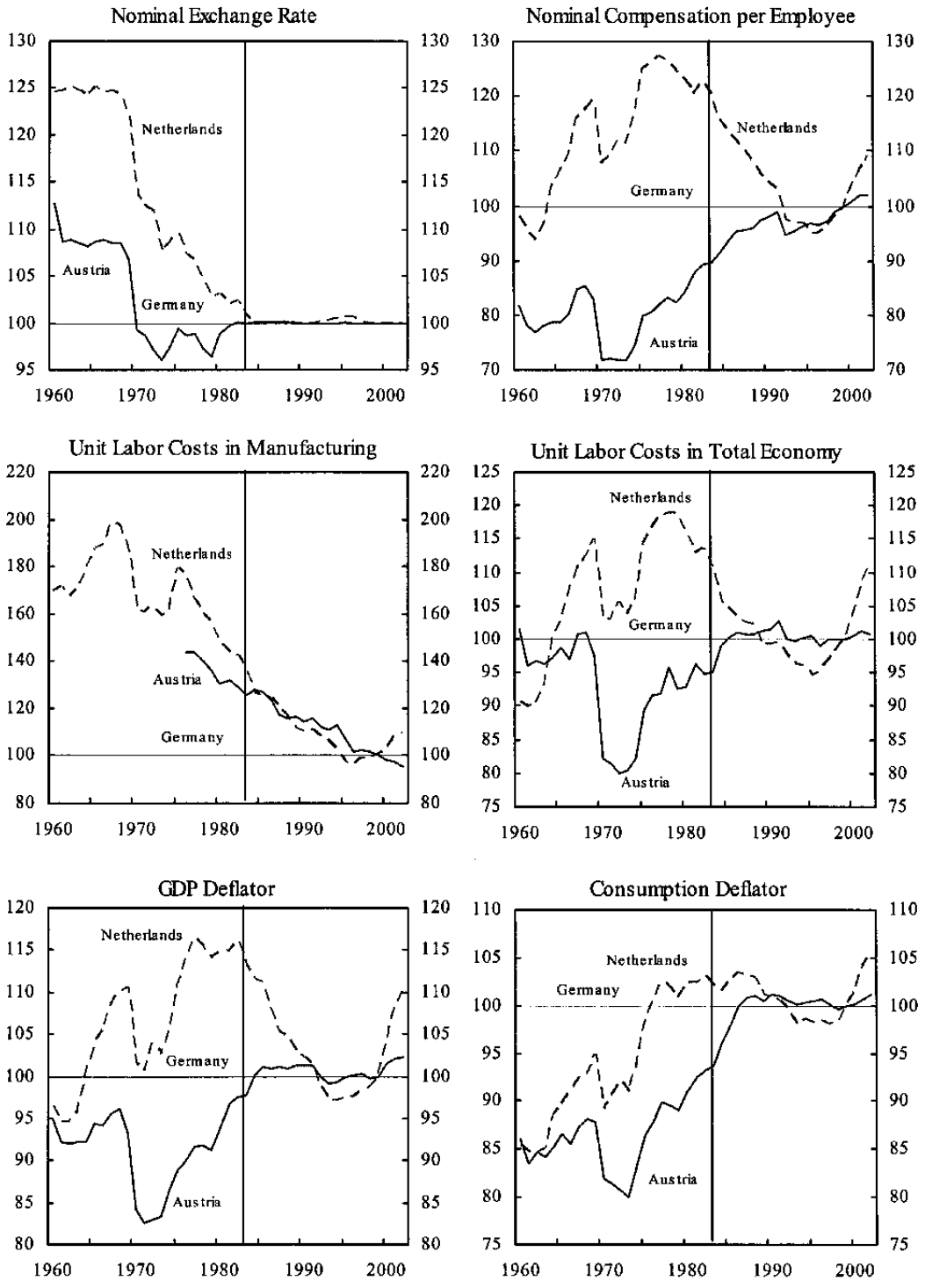
An illustrative simulation

70. The need for cross-country relative wage adjustment in EMU will depend on the frequency, nature and size of asymmetric shocks in EMU. The occurrence of such shocks is inherently difficult to predict in part because of the endogenous nature of the optimal currency area criteria (Frankel and Rose 1998, and Issing 2001). Nonetheless, the experience of the quasi-monetary union between Germany, Austria, and the Netherlands since the early 1980s suggests that considerable movements in relative wage levels, unit labor costs, and prices may continue even among highly integrated economies (Figure 8).

71. The interaction of the average inflation target with relative wage adjustments within and across countries in the presence of wage rigidities has been analyzed in a stochastic, multi-sector simulation model by Holden 2002. Such simulations are clearly dependent on the calibration of shocks and response parameters for which there is limited hard evidence,

[12] The existence of multi-level collective bargaining in many European countries (national, regional, sectoral, firm level) in which each layer has to justify its existence may be one mechanism contributing to rigidities above the zero mark (Calmfors 1996).

Figure 8. Germany, Austria, Netherlands: Relative Wages and Prices 1/



Sources: European Commission; IMF; and staff calculations.

1/ Indices, expressed in common currency, relative to Germany, 1999=100.

and the results are merely indicative given the stylized nature of the model. Nonetheless, they illustrate that country-specific shocks may increase the fraction of workers who become unemployed when market-clearing real wage adjustments would require a nominal wage cut, thus giving rise to additional unemployment at low inflation rates. The simulation results recaptured in Table 7 indicate little difference between inflation rates of 2 percent and above, but reducing inflation to 1½ percent or below could entail significant, lasting costs.

Table 7. Euro Area: Long Run Inflation and Unemployment Rates (percent)

Inflation target	Unemployment rate	Proportion of wage cuts
0.0	9.5	8.2
0.5	9.3	4.6
1.0	8.6	3.1
1.4	7.8	0.4
1.9	7.1	0.1
2.5	6.9	0.1

Source: Holden, 2002.

72. A final important issue concerns the extent to which observed behavior during past periods of moderate to high inflation will change in the price stability regime of EMU (cf. the Lucas critique). Mainstream menu-cost theories predict the appearance of downward nominal rigidities at positive inflation that would disappear in a regime of price stability (Ball and Mankiw, 1995). If downward wage rigidity were binding in a low inflation environment, there would be quite strong incentives to get around the restriction by extending bonus and profit-sharing systems, for the benefit of both workers and firms. Nevertheless, a number of reasons suggest that it should not be taken for granted that downward wage flexibility would easily develop. The examples of Switzerland and Japan may be instructive: Fehr and Goette 2000 found a large degree of wage rigidity and no tendency for the proportion of wage cuts to rise in Switzerland even after an extended period (seven years) in which inflation was close to zero and productivity growth low. Nominal wages are currently stagnating or falling in Japan, but not by much: WEO expects -0.1 percent for hourly compensation in manufacturing in 2002, the fourth year of deflation. In the euro area, moreover, the downward rigidity rooted in employers' concerns about the impact of wage cuts on worker morale is reinforced by labor laws governing contract renegotiations and employment protection, which give workers a stronger hand in rejecting pay cuts, and which may not easily be changed. Because economies have operated for so long with positive inflation, it would likely take a long time for downward wage flexibility to develop.

73. Even if downward flexibility were to develop, falling prices and wages may not necessarily stabilize the economy in the short run—a debate which goes back to Keynes. In a closed-economy context DeLong and Summers 1986 showed that while lower prices and wages do ultimately increase output, the process of getting there via declining inflation causes the real interest rate to rise, and the latter effect may well swamp the former—in fact, the increasing degree of nominal rigidity in Western economies in the last century coincided with a dramatic decrease in cyclical volatility. In the open and highly integrated economies of EMU, improved competitiveness will strengthen the equilibrating effects of lower wages and prices, but such processes may still be slow.

74. Whereas downward rigidities may help to forestall deflationary risks in the economy, we next examine whether low inflation and interest rates might compromise the ability of central banks to avoid deflation in the face of large, negative shocks.

Zero bound on nominal interest rates

75. A positive rate of inflation may be preferable to absolute price stability if it reduces the chances that countercyclical monetary policy becomes constrained by the zero floor on nominal interest rates.[13] The significance of hitting the zero floor depends also on whether monetary policy retains some potency through other transmission channels (e.g., exchange rate intervention and expansion of the money base), on fiscal policy reactions, and on possible self-equilibrating forces in the economy (real balance effect). Two approaches to studying the importance of the zero interest rate constraint are explored in the following: the first is to look at the historical incidence of negative real interest rates; the second is stochastic model simulations.

Historical experience of the euro area

76. Zero *nominal* interest rates have been rare in the industrialized post-war world, with the important exception of Japan since 1998. High inflation in 1970s and 1980s made the zero floor for nominal rates an irrelevancy, and the higher rate of potential growth as well as widespread quantitative limits on credit expansion in the 1950s and 1960s limit the relevance of the experience from those low-inflation decades for today's conditions.

77. Summers, 1991 reported that ex post *real* interest rates in the United States had been negative about one third of the time since World War II. However, the more relevant concept is the *ex ante* short-term real interest rate (King, 1999). Using one-year-ahead survey expectations and interest rates observed at half-yearly intervals, King found that *ex ante* real interest rates in the U.S. had been negative only in three brief episodes (the second half of 1976 and the first half of 1977, and the first halves of 1980 and of 1993, comprising roughly 5 percent of the observations). In three of those half years the real rate was barely different from zero, while one observation was around -½ percent. Results for the U.K. show one instance of negative real rates over the same time span, which was, however, quantitatively insignificant.

78. Figure 10 uses historical IMF forecasts as a proxy for inflation expectations to calculate *ex ante* real short-term interest rates in Germany, France, Italy, and the United States since 1961. On this measure, real *ex ante* interest rates were negative only on few occasions and only when there was a run-up in inflation, especially around the 1974 oil shock. Too low real interest rates on this instance arguably constituted a policy error, which fed subsequent high inflation. Overall, there is little in these experiences to suggest that real interest rates may need to become negative in the face of adverse demand shocks at low inflation.

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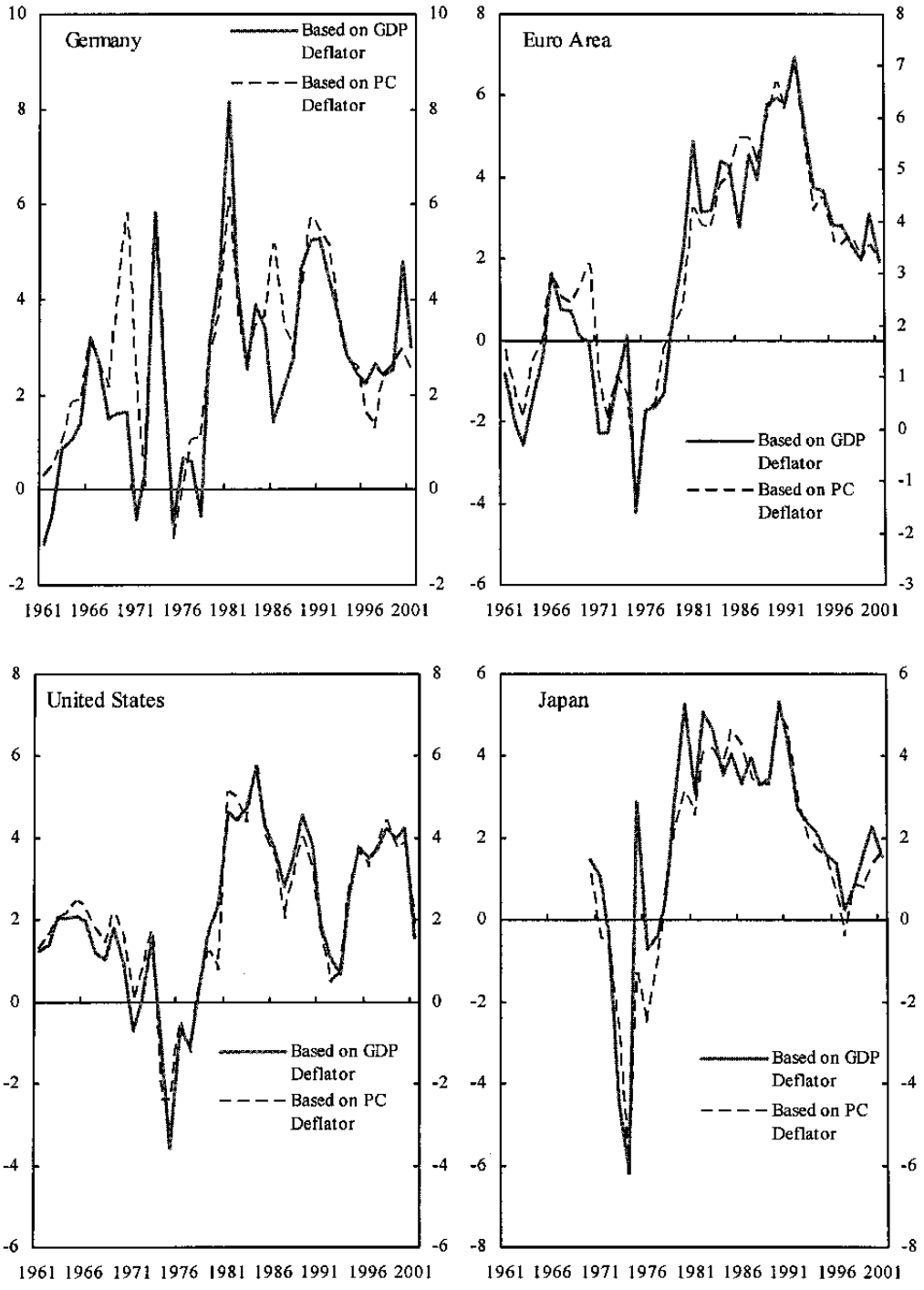
[13] This proposition was made by Keynes, 1936, and regained prominence in more recent times when taken up by Summers, 1991.

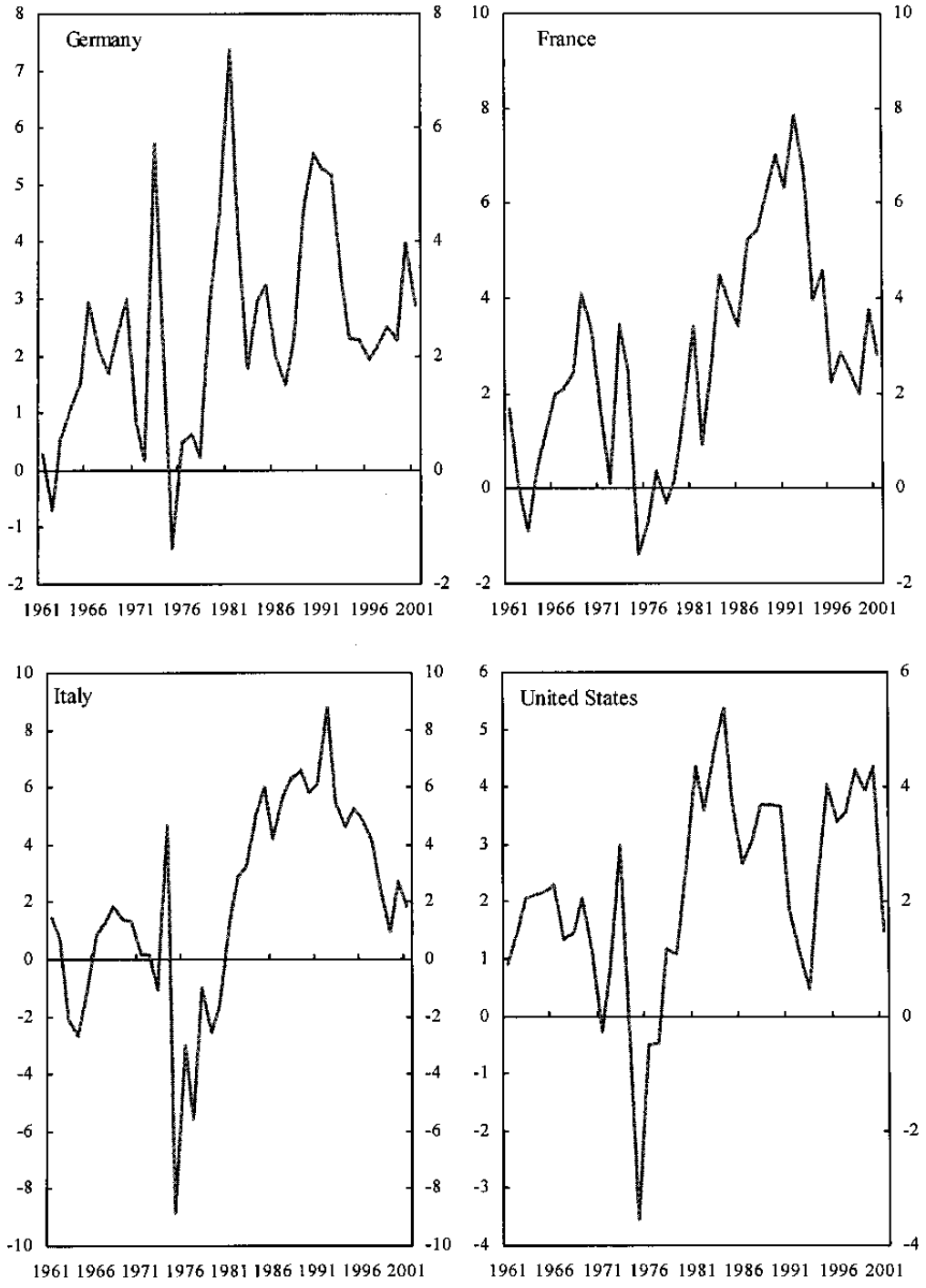
Figure 9. Ex Post Real Short-Term Interest Rates, 1961-2001



Source: IMF, European Commission.

Note: PC Deflator refers to the deflator of private consumption.

Figure 10. Ex Ante Real Short-Term Interest Rates, 1962-2001



Source: IMF, European Commission.

Note: Inflation expectations are based on May WEO forecasts of the current year change in the GDP deflator. WEO forecasts were not available for the 1960s. For each country, the inflation forecast series over the 1971-2001 was regressed on lagged and actual inflation, and expectations during the 1960s were retropolated by assuming the same degree of foresight then as in 1971-2001.

Simulations of stochastic models

79. Historical data covering periods with high inflation or high potential growth rates do not provide conclusive evidence on how binding the ZIF is likely to be in today's environment. Recent years have seen a proliferation of studies that explore the issue in stochastic model simulations. Most have focused on the United States but qualitative implications may be drawn for other countries. The following surveys the results, first for standard Taylor policy rules, and subsequently for alternative (more aggressive) policy rules, and adds some new evidence for the euro area.

(i) Simulations based on standard Taylor policy rules

80. Table 8 shows the probability that interest rates might hit the zero bound in three different model applications under different assumptions about the inflation target. The models range from small-scale new open macroeconomics models (Orphanides and Wieland, McCallum) to large-scale models (Reifschneider and Williams) with considerable variation in price and output dynamics and monetary transmission. The shocks and structural features of the models have been calibrated to U.S. rather than euro-area conditions, or, in the case of McCallum 2001, to a more generic "standard" open economy.

81. The probabilities are not strictly comparable across studies. For instance, the results quoted for Reifschneider and Williams, 1999 refer to the percent of time that the policy interest rate falls to zero in the simulations, whereas McCallum's results refer to the number of quarters in which the nominal interest rate is negative in his model. By allowing negative interest rates the latter approach tends to underestimate the severity of the zero bound.

Table 8. Probability that Interest Rates Become Zero Assuming Policy Follows a Standard Taylor Rule.

	-- Inflation target --			
	0.5	1	1.5	2
Orphanides and Wieland, 1998 1/	6	2	1	0
Reifschneider and Williams, 1999 2/	11	9	7	5
McCallum, 2001 3/	-	-	11	8

1/ Small calibrated U.S. model, and a neutral real rate of 1 percent.
2/ FRB/US model, assuming a neutral real rate of 2.5 percent.
3/ Small calibrated model, and a neutral real rate of 2.5 percent.
Note: some entries have been interpolated from neighbouring observations.

82. There is considerable variation in the results. Orphanides and Wieland (the first paper in this line of research) find low probabilities of hitting the zero floor and conclude that "the consequences of the zero bound are negligible for target inflation rates as low as 2 percent" although the constraint produces a "significant deterioration of the performance of the economy with targets between 0 and 1 percent." Their simulation assumes an unusually low level for the neutral interest rate, which presumably biases upward the probability of the constraint becoming binding. On the other hand, their model generates unusually low

variability of output and inflation, which has the opposite effect.[14] Reifschneider and Williams' results for the U.S. (using the Federal Reserve Board's FRB/US model) are broadly similar to the results for Japan in Hunt and Laxton, 2001, using the IMF's Multimod.[15]

83. The likelihood of hitting the zero target is not equivalent to the probability of ending up in a deflationary spiral, in which falling prices produce higher real rates which further depress demand and exacerbate negative price pressure. The probability of deflationary spirals is a good deal lower, cf. below. However, whenever the constraint becomes binding there is some loss of output and inflation stabilization relative to an optimal rule.

(ii) Extended Taylor rules

84. The literature has explored modifications to the policy rule which might reduce the likelihood of hitting the zero bound and generally help output and inflation stabilization. Modifications include variations on the parameters in the Taylor rule; addition of the lagged interest rate to the rule; asymmetric responses where rates are lowered more aggressively if inflation nears zero; and inclusion of price level objectives in the rule.

85. Some representative results are reported in Table 9. Relative to the standard Taylor rule, the model simulations do not unanimously point to higher or lower risk of hitting the zero floor—in some cases a more "aggressive" policy rule implies greater interest rate volatility and thus more frequent cases when the zero floor is binding, while in others more active policy has a preventive effect and leads to a fall

Table 9. Probability that Interest Rates Become Zero Assuming Policy Follows an Aggressive Taylor Rule.

	-- Inflation target --			
	0.5	1	1.5	2
Orphanides and Wieland, 1998 1/	23	9	6	2½
Reifschneider and Williams, 1999 2/	13	9	6	4
McCallum, 2001 3/	6	4	3	2
Vinals, 2000 4/	0	0	0	0

1/ Small calibrated U.S. model, and a neutral real rate of 1 percent.
2/ FRB/US model, assuming a neutral real rate of 2.5 percent.
3/ Small calibrated model, and a neutral real rate of 2.5 percent.
4/ Small calibrated euro area model, and a neutral rate of 3 percent.
Note: some entries have been interpolated from neighbouring observations.

[14] The standard deviations of the quarterly output gap and inflation generated by their model under the Taylor rule (ignoring the zero bound) are 1.0 and 0.7 percent, respectively. By way of comparison, the realized standard deviation of the euro-area output gap is 1.6 percent in quarterly data (1980Q1-2001Q4), and 1.4 percent in annual data (1980-2001). It is highly plausible that inflation variability will be lower in the EMU regime than in the past.

[15] Reifschneider and Williams increase the actual target rates of inflation that appear in the policy rule to compensate for the decline in average inflation outcomes that will otherwise arise in the face of the zero bound constraint. For example, to achieve an average outcome of 0.0 percent inflation, the actual target rate for inflation in the policy rule is 0.7 percent.

in the risk of zero interest rates (cf. also Rotemberg and Woodford, 1999; Batini and Haldane, 1999; and Levin, Wieland, and Williams, 1999). Vinals, 2000 represents an outlier in showing zero probabilities of hitting the zero floor even at very low inflation rates. One reason is that his calibration entails a volatility of detrended euro area output of 0.45 percent, which is low relative to the U.S. using the same methods (0.80 percent), and relative to other studies (cf. footnote 14).

86. The simulations sometimes rely on assumptions that may be difficult to achieve in practice—for instance, although adding an element of price level targeting may be helpful for countries that have fallen in a deflationary spiral because it raises inflation expectations, the central bank may find it difficult to convince the public of its ability to deliver on its promise, as well as its willingness to endure inflation after the economy escapes the trap.

Implications for the euro area

87. How relevant is the zero bound issue for the euro area? The answer to that question depends in part on the comparative features of the euro area economy with respect to:

- ***The neutral rate***: the higher the steady state (or equilibrium) real interest rate in the economy, the lower the probability of the zero interest rate floor becoming binding. The equilibrium real interest rate is primarily determined by the natural rate of growth (the growth of the labor force and the rate of technical progress), and the propensity to save, which in turn hinges on the rate of time preference, the risk aversion of economic agents, government finances, and tax distortions. With global capital mobility providing an equalizing force across countries, the neutral rate in the euro area is likely to be similar to that of other industrialized countries, even if the area's comparatively modest potential output growth rates might suggest that the neutral rate is lower than, e.g., in the United States.[16]

- ***Inflation inertia*** can cut both ways.[17] With high inflation inertia, real shocks initially dislocate inflation less, but then the real economy needs to be shifted more to restore inflation to target. In the case of price shocks, the real economy needs to be shifted more to stabilize inflation. Historically, the euro area exhibited comparatively high inflation persistence, in part because of the interaction of oil price shocks with wage indexation and low real wage flexibility, and in part because of monetary policies (in

[16] Estimates of potential growth in the euro area are 2-2.5 percent (ECB), and 2.3-2.4 percent (IMF, OECD, and European Commission). In a dynamically efficient economy, the neutral interest rate is higher than potential growth in steady state, although it might be lower during transitions from one steady state to another.

[17] Here, inflation inertia denotes the weight on past inflation relative to forward-looking (model-consistent) inflation in determining near-term inflation expectations.

the 1970s and early 1980s) that allowed inflation to become ingrained in expectations. Recent experience suggests inflation inertia has declined in the area.

88. The likelihood of the zero constraint becoming binding depends also on the frequency, severity, and duration of the shocks hitting the economy; structural features of the economy including its openness and the monetary transmission mechanism; expectations formation; and the responses of the monetary authority before the zero bound becomes binding.

89. To explore the issue further, stochastic simulations were run with the euro-area block of IMF's Multimod.[18] Based on a neutral interest rate of 2.7 percent, the results are reported in Table 10 under the assumption that inflation persistence and price shocks remain in line with historical experience. Policy follows an optimal rule which responds more strongly to inflation and output gaps than a simple Taylor rule, and includes an asymmetric objective not to let the price level fall. This approach minimizes the probability of the zero interest rate floor becoming binding in the simulations.

90. The probabilities of the zero interest rate floor becoming binding are in line with the majority of those reported in Tables 8 and 9. Table 10 also reports the probabilities of falling into a deflationary trap over the course of a 100-year period if the economy is subjected to shocks similar to those that occurred during the 1980s and 1990s (a deflationary trap is a situation in which the model does not solve, so that monetary policy acting through the interest rate channel alone cannot restore the economy to equilibrium).[19] The probability is nil for an inflation target of 2 percent, rising to a 3 percent chance with an inflation target of 1½ percent, and some 10 percent if the target is zero inflation. These probabilities assume a perfectly credible commitment to generate future inflation under the optimal policy rule.

Table 10. Euro Area: Impact of Average Inflation Target on Probabilities of Zero Interest Rates and Deflation 1/

	-- Inflation target --			
	½	1	1½	2
Optimal policy rule				
Probability of zero interest rates	16	11	9	3
Probability of a deflationary spiral	10	4	3	0
Standard deviation of output gap 2/ 3/	1.64	1.62	1.61	1.61

1/ Based on Multimod simulations and neutral real rate of 2.7 percent.
2/ This statistic is skewed heavily downwards by omitting the solution failures associated with deflationary spirals.
3/ The 1982-2001 standard deviation of the output gap was 1.41.

[18] Ben Hunt's assistance in designing and implementing the Multimod simulations is gratefully acknowledged.

[19] Prominent monetarists have challenged the key assumption that monetary policy will be rendered ineffective at the zero interest rate floor. See also Svensson, 2001 on "A Foolproof Way of Escaping From a Liquidity Trap."

91. In practice, the persistence in the inflation process as well as the standard deviation of price shocks seem likely to have declined in line with structural reforms enacted in the euro area in the 1990s and the regime shift to EMU which anchors inflation expectations more firmly than used to be the case. In this perspective, the probabilities of being caught in a deflationary spiral have probably decreased for each level of the inflation target.

92. Although the simulated probabilities of deflationary traps are clearly model- and parameter-specific, the cumulated evidence suggests that the risk of the zero interest rate floor becoming binding would be non-negligible if trend inflation rates were maintained significantly below 2 percent. Moreover, even if the probability of entering a deflationary spiral may not be great, Japan's experience is a sobering reminder that the ability of policy to escape the spiral could be limited. In this connection, prevention is far easier than cure and a high premium should be put on avoiding deflationary traps in the first place.

E. Conclusion

93. The Eurosystem has chosen to provide a definition of its price stability objective which is more specific than some central banks, e.g. the U.S. Federal Reserve and the Bank of Japan, and less specific than traditional inflation-targeting central banks. The criticism of the Eurosystem's target definition as ambiguous and asymmetric has come primarily from those who favor inflation targeting over other monetary strategies.

94. The differences between the ECB's current goal specification and those of inflation-targeting central banks are probably less important, and the relative merits of a point inflation target versus the current specification of the Eurosystem's objective more finely balanced, than acknowledged by many observers. On the one hand, the still-evolving nature of the HICP index argues against too precise a definition of the target, and the ECB is quite right to stress the need for monetary policy to respond flexibly to shocks of varying nature and intensity. Flexible inflation-targeters would not dissent from the latter view, however, and the medium term policy horizon adopted by the Eurosystem would accord substantial flexibility in this regard even with a point inflation target. At the same time, a point inflation target would probably facilitate communication and improve perceptions of ECB policies, and serve as a clearer guide for inflation expectations and policy debate than the current goal specification. Yet, the potential for such gains is modest since medium and long-term inflation expectations appear to be at least as stable and well-anchored in the euro area (at 1.8-1.9 percent) as among prominent inflation-targeters. Moreover, any potential gains from changing the goal specification would need to be weighed against possible credibility costs of doing so.

95. While neither this paper nor the economics profession more broadly has come to a clear conclusion concerning the optimal level of inflation in the euro area (or elsewhere) the same holds true for other issues (e.g., monetary transmission) on which the practice of monetary policy nevertheless requires policy makers to take a stance. The reading of the evidence presented in this paper suggests that:

- *Inflation measurement bias* in the harmonized European price indices, while inherently unknowable, may account for a significant fraction of observed inflation; the bias appear to be smaller than in some other cases (e.g. the Bank of England's RPIX inflation target of 2.5 percent may well correspond to inflation of 2 percent or less in terms of the UK HICP). Formula biases are likely smaller than the widely quoted Boskin estimate for the U.S. CPI, but other elements of measurement bias appear unlikely to be smaller than in the United States.

- *Balassa-Samuelson and price convergence* processes are liable to cause long-lasting differences in trend inflation across EMU members. The analysis here suggests that such differences are likely to be smaller than indicated by estimates of the Balassa-Samuelson model, but high-income countries could still experience trend inflation at ¼-½ percentage points below the euro average, while catching-up countries could be roughly 1 percentage points above; moreover, such differences would become more pronounced in future if EMU were enlarged to include countries with significantly lower GDP per head than current members.

- *Downward nominal wage rigidities* appear quite prominent and could restrain or delay relative wage adjustment across occupations and regions within countries, as well as across countries in response to asymmetric shocks. Inflation may also distort price signals in the labor market, however, and there is little firm evidence to suggest that the upper limit of the ECB's definition of price stability is too strict to allow such processes to play out. Illustrative simulations suggest that potential costs increase as the target is lowered below 2 percent.

- The *zero-interest rate floor* under nominal interest rates may constrain monetary policy effectiveness if the economy is threatened by deflation; the reading of the evidence presented here suggests that the risks of monetary policy being constrained by the zero-interest rate floor are minor for inflation targets down to 1½-2 percent, with little hard evidence to distinguish between the two, whereas they increase progressively for targets below that level. Although monetary policy may also act through other channels, experience from around the world suggests that prevention is far easier than cure, and uncertainty argues for a risk-averse approach.

96. Whereas the benefits of driving inflation significantly below 2 percent seem either small (e.g., lower shoe-leather costs) or better dealt with through other means (tax reform), the potential costs would appear to rise progressively for rates below 1½-2 percent. Consequently, the analysis suggests that an inflation target toward the upper end of the ECB's price stability range would strike a judicious balance between reaping the benefits of price stability—including substantial and permanent gains from reduced tax distortions, and reduced 'sand' effects in the price mechanism—while allowing inflation to 'lubricate the wheels' of price and wage adjustment and safeguard against deflation. Individually, none of the issues discussed is decisive, but collectively the balance of considerations suggests that the inflation target should not be lower in the diverse euro area than for individual countries that have adopted inflation targets.

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II. The ECB's Policy Strategy: An Assessment of the Role of the Money Pillar[1]

A. Introduction

1. In October 1998, the ECB announced its monetary policy strategy, opting for an unorthodox mix of elements of monetary and inflation targeting traditions:

- First, in a move that echoed the Bundesbank's monetary targeting approach, the ECB assigned money a prominent role as the "first pillar" of its strategy, noting that money represents a "*natural, firm, and reliable nominal anchor for monetary policy.*"[2] In particular, a specific reference value for M3 growth was set "*to help the Governing Council analyze and present the information in the monetary aggregates in a manner that offers a coherent and credible guide for monetary policy aimed at price stability.*"[3]

- Second, introducing an element closely associated with the inflation targeting approach, the ECB's strategy includes a "second pillar" that gauges inflation trends based on "*a variety of factors that normally affect price developments in the shorter term.*" Under this second pillar, the ECB's staff prepares and publishes macroeconomic projections twice a year, providing inter alia a range forecast for the annual HICP inflation rate up to 2 years ahead assuming constant policy interest rates.

- Finally, as the third element of its monetary strategy and again echoing but not exactly adopting the inflation targeting tradition, the ECB defined price stability as "*a year-on-year increase in the HICP for the euro area of below 2 percent,*" a goal that is to be achieved "*over the medium term.*"

2. After almost 4 years of policy operations, the ECB's hybrid strategy has remained controversial. The mixed perceptions that have met the strategy are illustrated by three broad assessments that appear to be shared by many outside observers:

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[1] Prepared by Albert Jaeger (ajaeger@imf.org).

[2] ECB (1999, p. 47), *Monthly Bulletin,* January.

[3] Later in December 1998, the Governing Council set the reference value for M3 growth at 4½ percent, reflecting assumptions of 2-2½ percent growth of real potential output and a trend decline in M3 velocity of ½-1 percent. The specified ranges for output and velocity growth in combination with the 4½ percent reference value appear to signal a commitment to aim at long-run inflation to remain in a range of 1-2 percent.

- The role of the first or monetary pillar in guiding monetary analysis and policy decisions within the two-pillar architecture remains opaque.[4]

- At least at times, it was difficult to square policy decisions with the ECB's communication of its two-pillar strategy.[5]

- At the same time, the ECB's policy decisions are seen to have generally been on the mark, and the ECB has established its credibility notwithstanding its status as a young central bank and a difficult macroeconomic environment characterized by a plethora of demand and supply shocks.[6]

3. Against this background, the purpose of this paper is twofold: (i) to discuss rationales for a monetary pillar in the ECB's strategy; and (ii) to assess whether the ECB's communication has been consistent with what the chapter considers sensible rationales for a monetary pillar.

4. The rest of the paper consists of six sections:

- Section B reviews the ECB's actual communication of the two-pillar strategy's role in policy analysis and decision making during the last 3½ years. The review suggests that the ECB's communication of the role of the money pillar has evolved and that there may indeed have been gaps between the ECB's "words" and "deeds."

- Section C discusses the policy challenge of putting in place a credible nominal anchor for price stability. In particular, using a stylized example for the inflation process, the section discusses the constraints on inflation implied by conventional inflation targeting as a benchmark for evaluating the ECB's strategy.

- Section D suggests that the two-pillar strategy could be viewed as a modified version of inflation targeting, where the central bank, on the one hand, avoids announcing a precise medium-term inflation point or range target, but, on the other hand, uses an explicit long-run nominal anchor (the reference value for M3) for pinning down long-run inflation expectations. The section discusses several rationales for adopting this twist on more conventional inflation targeting strategies: (i) past experience with asset price bubbles suggests that the buildup phase of a bubble can be consistent with

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[4] E.g., Blinder et.al. (2001) called the two-pillar setup "confusing;" on the more abrasive side, the CEPR report by Begg et.al. (2002) referred to the first pillar as the "poison pillar."

[5] De Grauwe (2002) refers to a gap between the ECB's "words and deeds."

[6] For example, while the 2002 CEPR report by Begg et.al. "Monitoring the European Central Bank" is highly critical of the ECB's strategy, the report concludes that the ECB's policy stance had responded well to a difficult macroeconomic environment.

a low and stable medium-term inflation outlook while the buildup of imbalances is accompanied by rapid money and credit growth—the ECB strategy's allowance for an explicit role for monitoring money (and credit) may provide some insurance against the buildup of area-wide asset bubbles; (ii) uncertainties about the size and persistence of inflation shocks in the euro area could argue against a conventional inflation targeting strategy because keeping inflation in a narrow range could come at the cost of increased variability of output; and (iii) there are strong convictions among euro-area policy makers that money can indeed provide a "natural, firm, and reliable nominal anchor" for long-run price stability, convictions that appear to be rooted in member countries' collective postwar experiences with money and inflation.

- Section E examines the credentials of money as a long-run anchor by looking at the (frequency-domain) coherence between inflation and money growth in selected industrial countries over the last 40 years. The link between inflation and nominal money growth at the lower (or long-run) frequencies (defined as longer-run cycles in money and inflation taking more than 8 years to complete) is found to be very strong—consistent with the idea of money as an effective "low-frequency anchor." The link between inflation and money at the higher (or medium-run) frequencies (cycles that last less than 8 years) appears, however, to be much weaker, suggesting that money serves best as a long-run anchor of inflation and complements (rather than competes with) the medium-run inflation outlook provided by the second pillar's analysis.

- Section F considers member countries' formative experiences with inflation and money growth during 1960-98. It suggests, on the one hand, that monetary developments for the area as a whole provided clear and early signals of the dismal inflation trends of the 1970s and early 1980s. On the other hand, an empirical measure of central bank credibility based on long-term bond yields suggests that the use of money as a long-run anchor provided the Bundesbank with an unusually high degree of credibility—in fact, estimates based on an unobserved components model seem to suggest that bond yields in Germany during the last 40 years were generally consistent with long-term inflation expectations of about 2 percent, although observed inflation exceeded 2 percent much of that time.

- Finally, Section G summarizes and concludes.

B. The ECB's Communication of its Two-Pillar Strategy

5. As emphasized in the ECB's January 1999 *Monthly Bulletin* (p. 44), an effective monetary policy strategy "*must be clear and understandable.*" Almost 3½ years of operational experience with the two-pillar strategy suggest, however, that the ECB's communication of its thinking and decision making has not always been "clear and understandable." Indeed, as early as in June 2000, Issing (2000) diagnosed an emerging "communication gap."

6. At an abstract level, effective communication requires that senders and recipients of messages share a common framework for decoding messages and have a mutual understanding of what the focus of communication should be. In an attempt to account for the ECB's communication gap, Issing (2000) puts the onus for closing the gap squarely on the recipients of the ECB's messages, referring inter alia to journalists' unwarranted focus on peripheral issues such as the vicissitudes of the euro exchange rate (instead of focusing on internal price stability), to academic critics' proclivity to convert monetary policy strategies into simple stylized decision rules (instead of seeing strategies as disciplining devices for conducting analysis and making policy decisions), and to market participants' ingrained preference for predictable policy actions (instead of recognizing the pervasive uncertainty faced by the Governing Council).

7. While there can be little doubt that effective communication of a monetary policy strategy requires some measure of "cooperation" from recipients, communication of the two-pillar strategy could also have suffered from problems on the sender's side, such as confusing signals about the relative role and importance of the various elements of the strategy. This section reviews a small but influential portion of the ECB's public communication of its two-pillar strategy, drawing in part on the ECB's regular press conferences after Governing Council meetings and focusing on four interrelated issues: (i) the relative importance or status of the two pillars in policy decisions; (ii) the relevant time horizons for gauging risks to price stability under the two pillars; (iii) the assessment of what constitutes "significant deviations" from the M3 reference value; and (iv) the role and status of output fluctuations in the two-pillar strategy.

8. Some basic facts regarding the ECB's policy decisions and key macroeconomic developments during the last 3½ years are brought out by Figure 1. The upper-left panel shows the path for the main refinancing rate and the (three-month centered average) for M3 growth relative to the 4½ percent reference value. The upper-right panel plots the main refinancing rate against an estimate of the real money gap (which was arbitrarily normalized at zero in January 1999). The lower-left panel shows HICP inflation developments and the main refinancing rate. Finally, the lower-right panel juxtaposes an indicator of slack in the real economy (capacity utilization in industry) with the path for the main refinancing rate.

9. Initial ECB comments on its strategy suggested that the first pillar would not only be prominent but provide the dominant input into policy decisions. At the presentation of the ECB's policy strategy in October 1998, the introductory statement noted (emphasis added) that the two-pillar includes a "*prominent role for money*" and that "*deviations of current monetary growth from the reference value would, under normal circumstances, signal risks to price stability.*" When President Duisenberg was asked on the relative importance of the two pillars, he noted that "... *it is not a coincidence that I have used the words that money will play a prominent role. So if you call it the two pillars, one pillar is thicker than the other is, or stronger than the other, but how much I couldn't tell you.*".

10. However, later ECB statements on the relative roles of the two pillars tended to water down these unequivocal statements. In particular, increasing stress was put on the need to undertake a "*comprehensive monetary analysis*" that goes beyond "*a comparison between M3 growth and the reference value*;" moreover, "*M3 growth may undershoot or overshoot the reference value temporarily without this necessarily being a cause for concern*;" and "*monetary data may be, on occasions, subject to special influences which temporarily impair the information content on future price developments.*"[7] Issing (2001) appeared to go a step further in re-stating the role of the first pillar relative to initial pronouncements by noting (emphasis added) that *"the prominent role assigned to money implies that the ECB is committed not to disregard the information content of monetary and credit aggregates, as this information can be expected to prove useful in forward-looking monetary policy decisions.*"

11. As regards communication about the relevant time horizons covered by the two pillars, it is convenient to use frequency-domain terminology to distinguish between three separate time horizons for the analysis of inflation pressures. In this paper, the "long run" or the "lower frequencies" will refer to cycles in inflation that take more than 8 years to complete. The "medium run" or the "business-cycle frequencies" refer to cycles in inflation that take 2-8 years to complete. Finally, the "short run" or the "higher frequencies" refer to cycles taking less than 2 years to complete. The cut-off point at 8 years is loosely motivated by traditions in business-cycle analysis, including the finding that the average U.S. postwar cycle lasted 7-8 years and that the widely used Hodrick-Prescott filter assumes a similar demarcation point between longer-run cycles and business cycles.[8] Against this background, what are the relative time horizons for inflation analysis under the two pillars?

12. Some of the ECB's communications on this issue appear to point to a "division of labor" between the two pillars, where the second pillar covers the higher and business cycle frequencies of the inflation process, while the first pillar acts as a "low-frequency crosscheck" on the second pillar analysis. For example, Issing et.al. (2001, p. 9) build their case for a prominent first pillar in part on what they suggest is "*the one-to-one relationship between money and prices in the long run*" and refer inter alia to Lucas (1980), who used frequency-domain techniques to pin down the relationship between U.S. inflation and money growth in the long run, as support for this position. A similar "division of labor" is suggested by Issing (2000) who notes (emphasis added) that "*one could think of both pillars as representing different, yet complementary, views (or models) of the structure of the economy as well as relating to different horizons of analysis.*"

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[7] All quotes are taken from an article on the "Framework and Tools of Monetary Analysis" in ECB (2001, pp. 41-58), *Monthly Bulletin*, May.

[8] See, for example, the unobserved components analysis of the U.S. business cycle in Harvey and Jaeger (1993).

13. However, other ECB communication efforts have suggested that the first pillar acts as a competitor for second-pillar analysis of inflation trends at the business-cycle frequencies, if not at the very short-term frequencies. This interpretation is suggested inter alia by: (i) the use of deviations of (three-months centered) M3 growth from a constant reference value (which, by design, is a high-frequency indicator of monetary developments) to signal first-pillar information on future price pressures; (ii) references to the two-pillar strategy as a cross-checking device, where the concept of cross-checking appears to refer to the inflation outlook at similar time horizons; and (iii) some of the ECB's research work endeavors to show that money and credit aggregates contain independent predictive power at the higher and business-cycle frequencies. For example, the results and arguments in Altimari (2001) appear to suggest that money and credit has been a powerful predictor for (synthetic) quarterly euro-area inflation rates for horizons up to 3 years and that predictive power at these time horizons is a key requirement for the first pillar's legitimacy.

14. Turning to the interpretation of deviations of M3 growth from the reference value, at the beginning of stage 3 of EMU, monthly M3 growth was close to the reference value and relatively small deviations were treated as a matter of serious concern. In the introductory statement to the press conference on December 22, 1998, it was noted that the latest "*annual growth rate of M3 stood at around 4.5 percent*" and that this was "*exactly in line with the reference value set by the Governing Council.*" In the introductory statement on March 4, 1999, the latest M3 growth rate stood at 4.9 percent, and while the Governing Council did not view this slight deviation as a signal for future inflationary pressures, it was noted that a "*close monitoring of monetary developments in the coming months remains necessary to give more conclusive evidence of the underlying causes and the permanent or temporary nature of the rise in M3 growth.*"

15. However, as the monthly deviations of M3 growth from the reference value became larger and more persistent (see Figure 1), and notwithstanding two significant downward revisions of M3 statistics to exclude non-resident holdings of negotiable instruments, communication of first-pillar developments began to put more and more stress on the need to interpret deviations from the reference value as only one element of a comprehensive monetary analysis.

16. Finally, as regards the status and role of output fluctuations under the two-pillar strategy, the Treaty clearly mandates the pursuit of price stability as the ECB's primary objective, but it also states that the ECB, without prejudice to the objective of price stability, should support the general economic policies in the Community including the achievement of sustainable growth and a high level of employment. The ECB's communication has strongly downplayed "output stabilization" as a separate concern of policy, and output developments are discussed under the second pillar in their role as signals of future inflation pressures. Issing et.al. (2001, p. 67) note that "*the (Treaty's) clear and precise statement on price stability as a primary objective corresponds to the widely agreed-upon robustness of the relationship between money and prices in the medium term. The uncertainties on the effectiveness of monetary policy as a means to stabilize output fluctuations are mirrored, instead, by the unwillingness to take a specific stance in this respect.*"

17. At the same time, the ECB's apparent reluctance to admit to concerns about economic outcomes other than medium-term price stability appears *not* to be mirrored by actual policy decisions. Begg et.al. (2002) have argued that the perhaps implicit view that stabilizing inflation is the best contribution monetary policy can make to stabilizing output may not be a good approximation for a low-inflation environment. In such a setting, inflation becomes a less reliable information variable on the state of the economy, and real indicators of the business cycle including measures of output slack will gain in signaling value for a central bank concerned about overall macroeconomic stability. In fact, the close association between policy rate changes and measures of output slack in the euro area (see lower-right panel in Figure 1) suggests that either output slack has been viewed by policy makers as being very closely correlated with inflation (a view not strongly supported by the lower-left hand panel in Figure 1) or it has been viewed as providing independent but relevant information on the state of the economy. With reference to a particular policy setting event, De Grauwe (2002) and others have noted that the ECB's April 1999 "precautionary cut" of interest rates may at least in part have reflected concerns about future output trends.

C. The Challenge of Anchoring Price Stability

18. The need for monetary policy to provide a "nominal anchor" that ties down current and expected inflation rates is hardly controversial. In this paper, a nominal anchor is interpreted as a commitment by the central bank to impose strict limits on the process generating the economy's inflation rate. A simple time-series model for the inflation rate (π_t) can illustrate the key issues involved:

$$(1) \qquad \pi_t = (1-\phi)\pi^* + \phi\pi_{t-1} + \eta_t,$$

where, assuming $|\phi|<1$, π^* is the inflation rate in the long run (which can also be interpreted as the central bank's long-run inflation target), the parameter ϕ captures the persistence of shocks to inflation, and the error term η_t represents uncorrelated inflation shocks, which are assumed to be distributed with mean zero and standard deviation σ_η. In this stylized model, the level and variability of inflation will depend on long-run inflation (π^*), the persistence of inflation (ϕ), and the variability of shocks (σ_η). In particular, and again assuming $|\phi|<1$, the level of inflation in the long run will average to π^*, and the variability of inflation (σ_π) is given by:

$$(2) \qquad \sigma_\pi = \sigma_\eta/(1 - \phi^2).$$

19. For annual data spanning 1961-98, the simple model (1) provides a (surprisingly) good fit for euro-area member countries' inflation histories (Table 1).[9] The results illustrate the large variety of historical inflation experiences across the area. Inflation rates range from a low of 3.1 percent for Germany to a high of 11.5 percent for Portugal, while the standard deviation of inflation shocks varied from a low of 1.1 percent for Germany to a high of 3.8 percent for Greece. At the same time, inflation processes in all countries were highly persistent, with estimated ϕ parameters in the range 0.75-0.91. Against this historical background, the ECB's longer-run inflation objective to keep π^* in the middle of a 1-2 percent range (as signaled by the assumptions underlying the M3 reference value) and the quantitative definition of price stability (year-on-year HICP increases below 2 percent in the medium run) clearly suggest that the ECB's inflation objectives amount to a major regime break relative to the area's past inflation experience.

20. Turning back to equation (1), a nominal anchor strategy can be interpreted as putting constraints on π^*, ϕ, and σ_η. While a central bank clearly needs to put some constraint on π^*, an announcement on the objective for π^* per se does not amount to a credible nominal anchor. The central bank must also signal a credible commitment of how it is going to keep inflation close to π^* in the long run. Traditionally, constraints on nominal variables such as the nominal exchange rate or the nominal stock of money have served as anchors, the anchoring premise being that putting constraints on changes in these variables also puts constraints on the inflation process.

21. The emergence (and widespread adoption) of inflation targeting as a viable monetary policy strategy since the early 1990s has established a new benchmark for anchoring price stability. This strategy can be interpreted as anchoring price stability via a commitment to set policy in such a way that expected inflation n periods ahead (π^e_{t+n}) stays within a (usually symmetric) range given by $\pm\varepsilon$, where ε is typically 1 percent in industrial countries and n (the "medium run") may or may not be specified explicitly.[10] In terms of the simple equation (1), inflation targeting amounts to a commitment of policy to put constraints on the parameters ϕ and σ_η such that deviations of actual inflation from π^* will be subject to verifiable limits.

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[9] Inflation rates are based on the price deflator for private consumption expenditure. The reference to "good fit" is relative to more general ARMA models of inflation, with the degree of fit measured by conventional information criteria. There is, however, some evidence that modeling π^* as a time-varying inflation objective (e.g. as a random walk) improves the fit of the equations for most countries, but without affecting the substance of the conclusions.

[10] This is stylized characterization of actual practices as regards point targets, target ranges, and target horizons. See Schaechter, Stone, and Zelmer (2000, pp. 6-14) for detailed descriptions of actual inflation targeting practices.

22. An inflation targeting framework's commitment to ensure a low-inflation environment is likely to act as a dampener on the size of inflation shocks (η), but even the most credible commitment to a low-inflation environment will not be able to reduce σ_η to zero. The persistence of inflation shocks (ϕ) can be directly lowered (or even come out negative) by setting monetary policy in a way that responds to future inflation pressures in a forward-looking manner, but the persistence of the inflation process may also be influenced by factors outside the control of monetary policy (for example, rigidities in the labor market) or involve tradeoffs (for example, if aiming at lower inflation volatility implies higher output volatility).

23. To illustrate the range of "admissible values" for ϕ and σ_η to prevent excessive over- or undershooting of a conventional target range, Table 2 reports the frequency of inflation over- or undershoots of a symmetric 1 percent range for different combinations of ϕ and σ_η. The inflation shocks are assumed to be normally distributed, and the results are by design independent of the assumed value for π^*. Taking a frequency of over- or undershoots of 0.10 as a (rather arbitrary) cutoff for differentiating between credible and less credible inflation targeting efforts, the results in the Table suggest that only combinations of relatively low inflation persistence and low variability of inflation shocks are consistent with keeping inflation in a conventional target range—in this model example, $(\phi + \sigma_\eta)$ needs to be smaller than 1.

24. For a given variability of inflation shocks, the stylized example in this section suggests that conventional inflation targeting requires policy to aim at "squeezing" the persistence of inflation shocks to allow the condition $\pi^e_{t+n} = \pi^*$ to be met.[11] In frequency-domain jargon, this policy condition amounts to "flattening the spectrum" of the inflation rate at the data frequencies that take more than n periods to complete. Intuitively, to signal a credible commitment to keep inflation at the lower frequencies at π^*, a conventional inflation targeting regime must aim at setting policy rates in such a way to keep expected inflation close to π^* at the business cycle frequencies.[12]

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[11] Low persistence of the inflation process appears to be the hallmark of the (very) short-time series on inflation generated by the inflation targeting regimes in New Zealand, Canada, the United Kingdom, and Sweden since 1993: estimates of AR(1) processes for these countries' annual CPI data suggest that σ_η was generally in the range 0.75-1.00 while ϕ was close to zero (if not negative in some countries) during 1993-2001.

[12] Milton Friedman (1962, p. 53-54) appears to have dismissed inflation targeting as a viable policy strategy out of doubts that the implied "flattening of the inflation rate spectrum" is feasible: "*There is unquestionably a close connection between monetary actions and the price level. But the connection is not so close, so invariable, or so direct that the objective of achieving a stable price level is an appropriate guide to the day-to-day activities of the*

(continued)

D. The ECB's Approach to Anchoring Price Stability

25. To what extent does the ECB's anchoring strategy deviate from the stylized inflation targeting benchmark laid out in the previous section? The ECB's monetary policy strategy clearly echoes key elements of the inflation targeting framework. At the same time, the strategy's quantitative definition of price stability does not provide a point target for π^* or π^e_{t+n}, and neither does it specify a conventional inflation target range. Couched in the perhaps overly narrow terms of equation (1), the ECB's implicit medium-term inflation target could be interpreted as being consistent with higher persistence and/or variability of inflation shocks than required by conventional inflation targeting. At the same time, and again viewed in the context of equation (1), the first pillar, as embodied in the specific reference value for M3 growth, could be interpreted as signaling a commitment "to peg" the long-run inflation rate π^* at some 1½ percent (with the assumptions on long-run output and velocity growth underlying the calculation of the reference value seemingly pointing to a range for π^* of 1-2 percent).

26. In terms of a stylized inflation fan chart, the two-pillar strategy could be visualized as seeking to constrain uncertainty about the inflation rate in the long run, at a horizon well beyond the typical fan chart "inflation cone" that usually reaches only 8-12 quarters into the future. In fact, if both real output and velocity growth were so-called difference-stationary time series processes,[13] a monetary policy that constrained nominal M3 growth to 4½ percent in the long run would remove *all* uncertainty about the level of the long-run inflation rate (although uncertainties about the long-run price level would persist owing to the possibility of permanent shocks to the level of real output and velocity). The range-assumptions for real output and velocity growth underlying the M3 reference value suggest, however, that there is at least some uncertainty whether real output and velocity growth rates are indeed stationary around constant means. At the same time, the annual reviews of the M3 reference value calculation have the purpose to detect permanent shocks to real output and velocity growth early on, putting an effective constraint on any remaining long-run inflation rate uncertainty.

27. Nevertheless, why adopt this hybrid and seemingly complex (relative to conventional inflation targeting) anchoring strategy? A first consideration is that a long-run money anchor may provide some insurance against the occurrence of asset bubbles.[14] The "bubble argument" for the first pillar is based on two stylized facts:

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authorities. ... In the present state of our knowledge, it seems to me desirable to state the rule in terms of the behavior of the stock of money."

[13] Shocks to difference-stationary time series processes have permanent effects only on the level of the series, but their growth rates are stationary around a constant mean.

[14] See CEPS (2000) and Borio and Lowe (2002).

- Sustained runups in asset prices usually coincide with rapid growth in money and credit aggregates, as brought out by the relative experiences of the euro area, the United States, Japan, and the United Kingdom over the last 20 years (Figure 2).

- And the buildup phase of asset prices bubbles can be consistent with low- and stable inflation rates, perhaps because the asset price bubble is accompanied by an investment boom that boosts labor productivity (and with real wages catching up slowly to higher productivity slows unit labor cost) or because the exchange rate appreciates (crimping import price inflation) as increases in asset prices attract capital inflows. The Great Depression in the United States and Japan during the second half of the 1980s provide good illustrations of rapid asset price increases accompanied in a stable inflation environment. In the case of the buildup phase of the Great Depression, the level of the U.S. GNP deflator actually fell during 1925-29 while U.S. real GNP expanded at an average pace of close to 4 percent per annum. Japan's inflation rate based on the GDP deflator during the second half of the 1980s averaged 1¼ percent while real GDP growth averaged 4½ percent per annum.

28. More broadly, a low-frequency money anchor combined with a thorough analysis of financial sector balance sheets may provide early warning signals suggesting that the underlying monetary stance is pitched at an inappropriate level, signals that may not be easily picked up by a policy strategy that focuses attention on 8-12 quarters ahead inflation forecasts.[15]

29. Owing to the unprecedented nature of the EMU project, there are pervasive uncertainties about the euro area's economic structure regarding the typical shocks hitting the area, the propagation of these shocks, and the monetary transmission mechanism. These uncertainties may only be resolved gradually, with enlargement, however, likely to add fresh uncertainties. Quite apart from uncertainties about the euro area's economic structure, there may also be discernable features of the euro area that that could lead to persistent overshoots of narrow inflation target ranges. Two examples:

- The euro area is a large currency area, and the exchange rate is therefore likely to play less of a role in both the determination of domestic inflation and the monetary transmission mechanism. But this feature of the euro area in turn suggests that potentially large and persistent under- or overshootings of the euro exchange rate relative to its underlying equilibrium can not be ruled out, exchange rate gyrations that could leave persistent traces in the inflation process.

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[15] Christiano and Rostagno (2001) study several analytical examples illustrating that monitoring money growth can be a good insurance practice for monetary policy; in their examples, following an inflation targeting (Taylor) rule can leave the economy without a long-run anchor.

- As another example, history suggests that labor market institutions in key member countries are prone to lead to persistent over- and undershootings of unit labor cost relative to (full-employment) trend, an institutional feature often associated with an unstable underlying (natural) rate of unemployment, which in turn renders the control of medium-term inflation outcomes more difficult.

30. A strong conviction that money should have a special role in any anchoring strategy. Issing et.al. (2001, p. 9-10) point to "the one-to-one relationship between money and prices in the long run (as) one of the few results that have remained undisputed over time and across economists." More recently, this view has been questioned by Begg et.al. (2002). While the claim of a tight "one-to-one relationship" may indeed be too strong for typical low-inflation environments, the next section provides some re-assuring evidence on the effectiveness of a low-frequency money-anchor strategy.

31. The collective historical experiences of euro-area members provided strong backing for a prominent role of money. In the particular case of Germany, the Bundesbank's monetary targeting strategy proved successful as a credible signaling device for pinning down long-run inflation expectations. And other member countries were increasingly inclined to piggyback on Germany's money anchor strategy (albeit different countries at different speeds), a meeting of minds that paved the road to EMU. Section F reviews some of these historical experiences.

32. A final consideration could be is that the two-pillar strategy is a device for structuring the debates within the Governing Council and allows the chief economist to use monetary trend arguments strategically in his opening presentations during policy meetings.[16] Moreover, first-pillar analysis is by definition concerned with area-wide developments and may help ensure that the Governing Council (where 12 out of 18 members are NCB representatives) keeps a watchful eye on area-wide long-run inflation trends.

33. Have other central banks made similar choices as the ECB? Perhaps most interestingly, the Swiss National Bank (SNB)—a central bank with a long-standing money targeting tradition—also opted for the ECB-type definition of price stability. Rich (2000) argued that in Switzerland's case it would not have been advisable to precommit to keep the inflation rate within a narrow range at all times as inflation is subject to number of large shocks beyond the control of the SNB: "*Of course, the SNB could endeavor to quell short-run movements in the inflation rate by adjusting monetary policy, if necessary, drastically. However, if it were to use heavy artillery for keeping the inflation rate within a narrow range, it would likely do more harm than good because such actions would exacerbate unnecessarily fluctuations in real output and employment.*"

[16] See von Hagen and Brueckner (2001) on this point.

E. Money Growth and Inflation: Evidence from the Frequency Domain

34. The viability of the ECB's first pillar is premised on the assumption of some empirical link between money growth and inflation. The nature and interpretation of this link remains, however, controversial. While most economists subscribe to the notion that "inflation is a monetary phenomenon in the long run," this phrase leaves open what is meant by the "long run" and "monetary phenomenon." More recently, Begg et.al. (2002), building on work by De Grauwe and Polan (2001), have argued that even the long-run link between nominal money growth and inflation in countries that have operated in moderate inflation environments may be much looser than commonly assumed.

35. This section presents some cross-country evidence based on frequency domain analysis.[17] For the industrial country group, the upper-left panel of Figure 3 replicates the well-known close relationship between average CPI inflation rates and average broad money growth (averages were taken over the period 1961-2000, except in the case of the euro-area countries, where averages are for 1961-1998; for a few countries, annual money growth data were available only from 1965 onward).

36. Frequency domain analysis can be used to decompose the overall movements in a time series in cycles at different frequencies. The lower frequencies capture the cycles with longer durations and the higher frequencies capture the cycles with shorter durations. Applying frequency domain analysis to the link between nominal money growth and inflation is attractive because it helps address directly the issue of medium vs. long run. As the analysis uses annual data, the shortest possible cycle spans 2 years. For the purpose of this analysis, low-frequency cycles are defined as cycles taking more than 8 years to complete, while the remaining part of the frequency domain captures all cycles that take 2-8 years to complete. The coherence between two time series in the frequency domain can be interpreted as the degree of linear association (at all leads and lags), or, loosely speaking, as the R^2 of regressing inflation on all leads and lags of nominal money at a particular frequency.

37. For the period 1961-98, Figure 3 shows the coherence between nominal money growth and inflation for the euro area (weighted average of coherences of the twelve member countries) plus the coherences for the member country with the lowest inflation record (Germany) and the member country with highest inflation record (Greece). The plots suggest that the long-run link between inflation and nominal money growth is quite close at the lower frequencies but falls off drastically in the range of the business-cycle frequencies.

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[17] Lucas (1980) used frequency domain techniques to study the long-run link between money and inflation. See McCallum (1984) for a critique of attempts to test macroeconomic theories using these techniques. This paper uses frequency domain analysis only to bring out stylized facts.

38. The top-right panel of Figure 3 provides a cross-country perspective of the coherence measures averaged across all data frequencies, while the two bottom panels show separate results for the lower and business-cycle frequencies. The plots consistently suggest that the coherence is much stronger at the lower compared with the business-cycle frequencies, suggesting that the long-run link between inflation and nominal money growth is quite strong.[18]

39. To provide some intuition for these results, consider two alternative identities for decomposing the growth rate of nominal money (Δm_t):

(3) $\Delta m_t \equiv \pi_t + \Delta(m_t/p_t)$

(4) $\Delta m_t \equiv \pi_t + \Delta y_t - \Delta v_t$,

40. Where the first identity rewrites nominal money growth as the sum of inflation and real money growth $\Delta(m_t/p_t)$ and the second identity uses the quantity equation to rewrite nominal money growth as the sum of inflation, real output growth (Δy_t), and the growth rate of the velocity of money (Δv_t). In terms of equation (3), the frequency domain results suggest that changes in nominal money are mainly reflected in variability in real money at the business-cycle frequencies, but, if sustained, ultimately lead to changes in prices in the long run. In terms of equation (4), and assuming that nominal money and output growth are unrelated in the long run, the apparent "disconnect" between money growth and inflation at the business-cycle frequencies should reflect mostly the medium-run variability of velocity growth. But as long as velocity growth itself does not undergo permanent (as opposed to temporary) shifts, a close link between inflation and nominal money growth should obtain in the long run.

41. The results of the frequency-domain analysis are consistent with the "Swiss argument" that monetary policy strategies that use money as an anchor are likely to face difficult communication problems.[19] The Swiss National Bank decided at end-1999 to abandon the explicit monetary targeting elements of its strategy, partly on the grounds that there can be considerable variability in nominal (and real) money growth at the business cycle frequencies, variability that may not, however, signal threats to long-run price stability. But high variability of (nominal and real) money growth at the business-cycle frequencies

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[18] The results of frequency domain analysis based on relatively small sample sizes can be quite sensitive to prefiltering ("pre-whitening') of the data and the type of "spectral window" used for calculating the cross-spectrum. Some robustness analysis suggested that the lower-frequency results shown in Figures 3-4 are quite sturdy, but the coherence estimates at the business-cycle frequency can be sensitive to prefiltering without affecting the overall conclusions of this section.

[19] See Jordan, Peytrignet, and Rich (2000).

means that a monetary policy strategy that relies in part on communicating the meaning of monthly deviations of money growth from a reference value is likely to face a difficult task.

F. Pre-EMU Experiences with Money and Inflation

42. This section looks at area member countries' combined (synthetic) inflation experience against the background of monetary developments since 1960. The three main themes emerging from this (historical) analysis are: (i) the area's overall inflation rate was left largely unanchored by member countries' (synthetic) monetary policy during the last four decades; (ii) monetary developments during the 1960s and early 1970s provided clear, early warning signals that price stability was endangered; and (iii) the Bundesbank's monetary targeting approach successfully signaled a pre-commitment to maintain low long-run inflation rates at about 2 percent, notwithstanding persistent overshooting of actual inflation rates (relative to 2 percent).

43. The first part of the analysis centers on a "money market version" of the Phillips curve of the form:

$$(5) \qquad \pi_t = \pi_{t,t-1}^{c} + \alpha MGAP_{t-1} + \delta Z_t + \eta_t,$$

where π_t is the annual consumer price inflation rate, $\pi_{t,t-1}^{e}$ is the expectation of annual inflation in year t formed at t-1, $MGAP_t$ represents the real money gap, Z_t is a variable proxying supply shocks (in the empirical analysis below proxied by the terms of trade), and η_t is a regression error term. Gerlach and Svensson (2002) define the real money gap as the (logarithmic) difference between the actual real money stock (M_t/P_t) and the long-run equilibrium real money stock $(M_t/P_t)^*$:

$$(6) \qquad MGAP_t = \ln(M_t/P_t) - \ln(M_t/P_t)^* \equiv \ln(M_t/P_t) + \ln(V_t^*) - \ln(Y_t^*).$$

As shown in (6), the long-run equilibrium money stock can be re-written as the difference between the (logarithms) of long-run velocity of money (V_t^*) and real potential output (Y_t^*).

44. To estimate (5) based on time series data, it is necessary to specify how inflation expectations evolve over time and derive an estimate of the money gap. As regards formation of inflation expectations, this note uses the following process for annual data:

$$(7) \qquad \pi_{t,t-1}^{e} = (1-\phi)\pi^* + \phi\pi_{t-1},$$

where π^* denotes an implicit inflation target (assumed to be constant) and ϕ captures the degree of credibility of the implicit inflation target (also assumed to be constant).[20] The long-

[20] The part of this section on the Bundesbank's monetary targeting experience considers an approach to modeling inflation expectations and credibility that allows time-variation in ϕ.

run real money stock was constructed by Hodrick-Prescott (HP) filtering of the logarithms of velocity and real output.[21]

45. The top two panels of Figure 5 show the evolution of the area's (synthetic) consumer price inflation during 1961-2001 relative to nominal (broad) money growth and the real money gap.[22] Consumer price inflation seemingly got out of control during the 1960s and 1970s, reaching double-digit levels by the second half of the 1970s, and was brought under control during the disinflation era of the second half of the 1980s and the 1990s. The level of nominal money growth and the real money gap appear to have provided clear early warning signals on the future flare up in inflation, and money growth and the gap contract well ahead of the steep disinflation path that took hold at the beginning of the 1980s.

46. Short-term interest rate developments mirrored monetary trends closely: the bottom-right panel shows the level of the real short-term interest rate (defined as the nominal short-term rate minus consumer price inflation) and suggests that the area's (synthetic) monetary stance was pitched at an unsustainably loose level well into the mid-1970s—real short term interest rates were negative—before disinflation was brought about by a sharp sustained tightening of the monetary stance that was only relaxed during the 1990s.

47. The history of the real short-term interest rate suggests that the "neutral or equilibrium real interest rate" may provide an additional useful low-frequency anchor for judging the long-run appropriateness of the monetary stance, particularly in case of large or persistent shocks to velocity growth. While the measurement of the "neutral real interest rate" is clearly a challenging task, analysts have not been deterred by similar challenges with regard to potential output or other unobservable economic variables.

48. Finally, the bottom-right panel highlights the unusual past variability of the area's levels of real unit labor cost (normalized at 100 in 1960) and of the unemployment rate—and both series suggest that the area's labor market environment provided a challenging backdrop for the conduct of monetary policy as the area's underlying (natural) unemployment rate failed to provide a "real anchor" for the economy.

49. Turning to the evidence on the predictive power of money for inflation developments, the following regression was implemented:

(8) $\pi_t = (1-\phi)\pi^* + \phi\pi_{t-1} + \alpha MGAP_{t-1} + \beta MGAP_{t-2} + \delta Z_t + \gamma Z_{t-1} + \eta_t.$

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[21] Because the analysis uses annual data, the HP filter smoothing constant was fixed at 100. A more subtle approach would base the long-run estimates of velocity and potential output on explicit unobserved components modeling—but the gains in insights relative to using the paper's simple HP filtering approach appear to be modest.

[22] All data series are taken from the Commission's data base. The change in the terms of trade is the difference between export and import price inflation for goods and services.

Two comments on this particular specification. First, the constant "credibility coefficient" ϕ measures the persistence of shocks to inflation—an estimate close to 1 indicates that shocks were (on average) highly persistent and, at the extreme $\phi=1$, inflation would have had a unit root and would not have been anchored to an underlying target. Second, the inclusion of once- and twice-lagged money gaps allows testing how "hysteretic" inflation was in response to movements in the money gap. If $\alpha + \beta = 0$, the level of the real money gap did not matter for the evolution of future inflation. Applying OLS to (8), the estimation results (with standard errors in parenthesis) are:

(9) $\pi_t = 0.319 + 0.930\pi_{t-1} + 0.525MGAP_{t-1} - 0.360MGAP_{t-2} - 0.314Z_t + 0.345Z_{t-1}$

(0.279) (0.042) (0.128) (0.124) (0.036) (0.037)

Time range 1961-98 $R^2 = 0.971$ DW = 1.619

The results suggest that the inflation process was highly persistent (the null that $\phi=1$ can not be rejected using standard unit root tests) and that the money gap was a useful predictor of inflation. An F-test of the restriction $\alpha + \beta = 0$ suggests that both the change and the level of the real money gap matter for predicting future inflation (the marginal significance level for the test is 0.01). Including the output gap in the regression yields:

(10) $\pi_t = 0.227 + 0.947\pi_{t-1} + 0.516MGAP_{t-1} - 0.435MGAP_{t-2} - 0.33Z_t + 0.300Z_{t-1}$

(0.279) (0.042) (0.140) (0.154) (0.031) (0.034)

$+ 0.310YGAP_{t-1} - 0.155YGAP_{t-2}$

(0.098) (0.102)

Time range 1961-98 $R^2 = 0.976$ DW = 1.918

The results of regression (10) suggest that the money gap and the output gap are both powerful predictors of future inflation, in line with the results in Gerlach and Svensson (2002) for quarterly euro-area data for the period 1980-2001.

50. To provide some intuition for these results, note that the real money gap is, by construction, equal to the difference between the output gap and the velocity gap, i.e. $MGAP_t = YGAP_t - VELGAP_t$, and that a regression on the money gap alone is therefore equivalent to a restricted regression on the output and velocity gaps. In fact, the implied restrictions are rejected by an F-test at very low significance levels. Moreover, the unrestricted regression suggests that most of the predictive power of the money gap reflects the predictive power of the output gap.

51. For the period considered in this paper, and contrary to Gerlach's and Svensson's (2002) results, adding lagged nominal money growth (DM_{t-1}) to equation (8) adds significant power to predicting inflation:

(11) $\pi_t = 1.293 + 0.763\pi_{t-1} + 0.425MGAP_{t-1} - 0.239MGAP_{t-2} - 0.33Z_t + 0.30Z_{t-1} + 0.177DM_{t-1}$

(0.363) (0.059) (0.113) (0.111) (0.031) (0.034) (0.051)

Time range 1961-98 $R^2 = 0.978$ DW = 1.964

The last result is robust to including the output gap as well and suggests that the main predictive power of nominal money growth is likely to be found at the lower data frequencies, as also suggested by the frequency domain evidence in the previous section.

52. Achieving high credibility—defined as the degree to which the public's inflation expectations are anchored to the central bank's price stability objective—is a key objective of monetary policy. There is some empirical evidence suggesting that high credibility is associated with a more favorable short-run unemployment-inflation tradeoff—e.g. a positive aggregate demand shock in a high-credibility environment is followed by a much more subdued inflation response than in a low-credibility environment.[23] As regards institutional practices, central bank independence and the explicit use of nominal anchors for signaling a commitment to price stability have proven valuable tools for gaining and maintaining credibility.

53. The remainder of this section asks two questions relevant to understanding the euro area's past inflation experience and the role of the monetary anchor in the ECB's policy strategy: To what extent did the Bundesbank's monetary targeting approach succeed in pinning down long-run (low-frequency) expectations of inflation? And how has central bank credibility evolved in other key euro area countries?

54. The following analysis uses the time series information in nominal long-term bond yields and actual inflation rates to infer the extent to which a central bank has established its credibility. As the starting point, the annual 10-year nominal long-term interest rate can be approximated (via the Fisher equation) by the sum of the unobservable annual real interest rate component (r_t) and the unobservable inflation expectations over a 10-year horizon ($\pi_{t,10}^e$):

(12) $R_t = r_t + \pi_{t,10}^e$

Assume that annual inflation (π_t) evolves according to a univariate autoregressive process of order one with the autoregressive coefficient (ϕ_t) varying (drifting) in time:

(13) $\pi_t = (1-\phi_t)\pi^* + \phi_t\pi_{t-1} + \varepsilon_t$

[23] See Laxton and N'Diaye (2002) for empirical evidence supporting this statement.

where π^* is the underlying inflation target and ϕ_t evolves as a random walk driven by white-noise shocks (η_t):

(14) $\phi_t = \phi_{t-1} + \eta_t$.

55. For illustration, it is worthwhile to use (13) to construct explicitly the average expected inflation rate over a 2-year horizon at time t-1:

(15) $\pi_{t,2}^e = [\pi^*(1-\phi_{t-1})(1+\phi_{t-1}) + \phi_{t-1}(\phi_{t-1}\pi_{t-1})]/2$.

Equation (15), which can be generalized to 10-year inflation expectations, illustrates that as ϕ_t approaches 1, inflation expectations are increasingly conditioned on the actual realization of inflation in period t-1. At the other extreme, if ϕ_t approaches 0, inflation expectations are closely tethered to the inflation target π^*.

56. Estimates of ϕ_t can be used to derive the following standardized measure of central bank credibility (c_t):

(16) $c_t = [(1-\phi_t)\pi^*]^2/\{[(1-\phi_t)\pi^*]^2 + [\phi_t(\pi^* - \pi_{t-1})]^2\}$,

which constrains credibility c_t in the interval $0 \leq c_t \leq 1$:

- High credibility (c_t close to 1) means that 10-year inflation expectations are anchored to the long-run inflation target rate (π^*), independently of the deviation of current inflation from this target rate. In other words, in a high-credibility regime, observed inflation is expected to revert to π^*, and actual inflation developments therefore leave little trace in ten-year expectations of inflation.

- Low credibility (c_t close to 0), by contrast, means that 10-year inflation expectations are mainly based on observed annual inflation developments, and deviations of observed inflation from the target rate tend to be quickly incorporated into 10-year expectations of inflation.

57. To estimate the model, the unobserved real interest rate component is assumed to follow a random walk:

(17) $r_t = r_{t-1} + \xi_t$,

where ξ_t is a white noise term, and π^* was fixed at 2 percent. To estimate the model, the equations were put in state-space form and the model's likelihood was maximized using the Kalman filter.

58. Figure 6 presents the estimates for the credibility parameter graphically, plotting the credibility measure for Germany against the results for three euro-area countries: the Netherlands, France, and Italy. The plots seem to support three statements:

- While the Bundesbank's inflation-fighting credibility was bruised temporarily by the oil price shocks of the 1970s, credibility recovered quickly after these short episodes notwithstanding the persistent overshooting of the (assumed) 2 percent underlying inflation target.[24] It is difficult not to attribute this outcome to the Bundesbank's distinct monetary targeting strategy that sought to establish a long-run anchor for price stability and inflation expectations.[25]

- By pegging the guilder to the deutsche mark, the Netherlands early on piggybacked on the credibility-enhancing effects of Germany's monetary policy strategy, mirroring almost one-for-one Germany's credibility performance.

- France and Italy literally touched (credibility) bottom before shifting gears and converging to Germany's high credibility regime—in the case of France this occurred in the mid-1980s while in the case of Italy the regime change was delayed almost to the onset of stage 3 of EMU.

G. Summary and Conclusions

59. From a historical perspective, the adoption of an explicit monetary pillar in the ECB's monetary policy strategy may well have reflected the need to strike a compromise between monetary and inflation targeting traditions. As put by Marshall (1999, p. 278): *"A 'reference value' (for money growth) was vague enough to soothe those who believed money was no longer reliable enough to justify being a target, but explicit enough to mollify the monetarists. Everyone could read what they wished into the word."*

60. Notwithstanding its genesis, however, the ECB's two-pillar strategy appears to mesh well with a number of considerations:

- As a stylized fact, asset price bubbles tend to be accompanied by rapid money and credit growth and can build up in a stable and low-inflation environment. In such a setting, money may be able to provide valuable early warning signals suggesting that the underlying monetary stance is pitched at an inappropriate level to maintain macroeconomic stability in the longer run, signals that may not be picked up by an 8-12 quarters ahead inflation forecast.

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[24] Germany's year-on-year inflation targets implicit in the money growth targets (base money during 1974-87 and M3 during 1988-98) during this period were at times above 2 percent.

[25] The opposite view, namely that the Bundesbank's monetary policy strategy succeeded despite its monetary targeting approach, has, however, many adherents.

- While the strategy does not include a precise medium-term point or range target for inflation, the first pillar's reference value for M3 growth appears to set an implicit target for long-run inflation in the range of 1-2 percent. Several institutional features of the euro-area economy—including the possibility of large, persistent exchange rate swings and wage setting institutions that are prone to persistent over- or undershooting of real wage claims relative to full-employment trends—suggest that keeping a tight lid on medium-term movements of the area's inflation rate could prove costly in terms of additional variability in output and employment.

- The first-pillar analysis is by definition concerned with area-wide developments, ensuring that the Governing Council (where 12 out of 18 members are NCB representatives) keeps an eye on area-wide long-run inflation trends.

- Finally, the idea that money can provide a reliable long-run anchor for long-run price stability appears to be deeply rooted in the euro area's collective postwar experiences with money and inflation.

61. However, the two-pillar strategy has also proven a taxing framework for communicating policy decisions. Some of the communication difficulties may be rooted in the design of any policy strategy that incorporates money in view of the apparently loose link between money and inflation at all but the long-run data frequencies. But some of the difficulties may also reflect inadequate communication efforts: e.g. the first pillar was at times described as being the "primary or thicker pillar," when its actual role should be mainly to serve as a "long-run cross-check" on the second pillar medium-run inflation outlook; the first pillar was presented as providing a competing (rather than a complementing) perspective on medium-term inflation pressures; and relatively small deviations of monthly M3 growth from its reference value were at times treated as having grave importance for the medium-run inflation outlook when the empirical evidence appears to suggest that money has, at best, moderate predictive power at business-cycle frequencies.

62. As a final cautionary note, it can take a considerable time span for assessments of monetary policy strategies to settle around a widely shared view, particularly when the strategy in question has new and unorthodox elements. The inclusion of a monetary pillar in the ECB's strategy has clearly been an unorthodox step, particularly given that more recently money has largely disappeared from popular macro models. A monetary policy strategy that keeps money firmly on-stage, however, may turn out to be prudent in the longer run, not least in view of Mervyn King's recent conclusion: "*... the absence of money in the standard models which economists use will cause problems in the future ... Money, I conjecture, will regain an important place in the conversation of economists.*"[26]

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[26] "No Money, No Inflation," *Bank of England Quarterly Bulletin*, Summer 2002 (p. 174).

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Table 1. Euro Area: Persistence and Variability of Consumer Price Inflation, 1961-98

Country	Estimated parameters: 1/ π^*	ϕ	σ_η	Memo item σ_π
Germany	3.08	0.81	1.09	1.75
France	5.07	0.91	1.63	3.59
Italy	8.04	0.87	2.52	5.19
Spain	8.38	0.85	2.52	4.91
Austria	3.50	0.80	1.26	1.97
Belgium	4.40	0.75	1.96	2.90
Finland	6.00	0.82	2.42	4.11
Greece	11.19	0.84	3.78	7.15
Ireland	6.00	0.88	2.56	5.37
Luxembourg	4.20	0.84	1.46	2.69
Netherlands	4.10	0.81	1.51	2.57
Portugal	11.46	0.87	3.54	7.16
Euro area	5.79	0.92	1.49	3.53

Source: Staff estimates based on equation (1) in text.

1/ Regression is based on annual data 1961-98; π^* denotes estimated average inflation; ϕ is the autoregressive coefficient; σ_η denotes standard deviation of inflation shocks; and σ_π is the standard deviation of inflation.

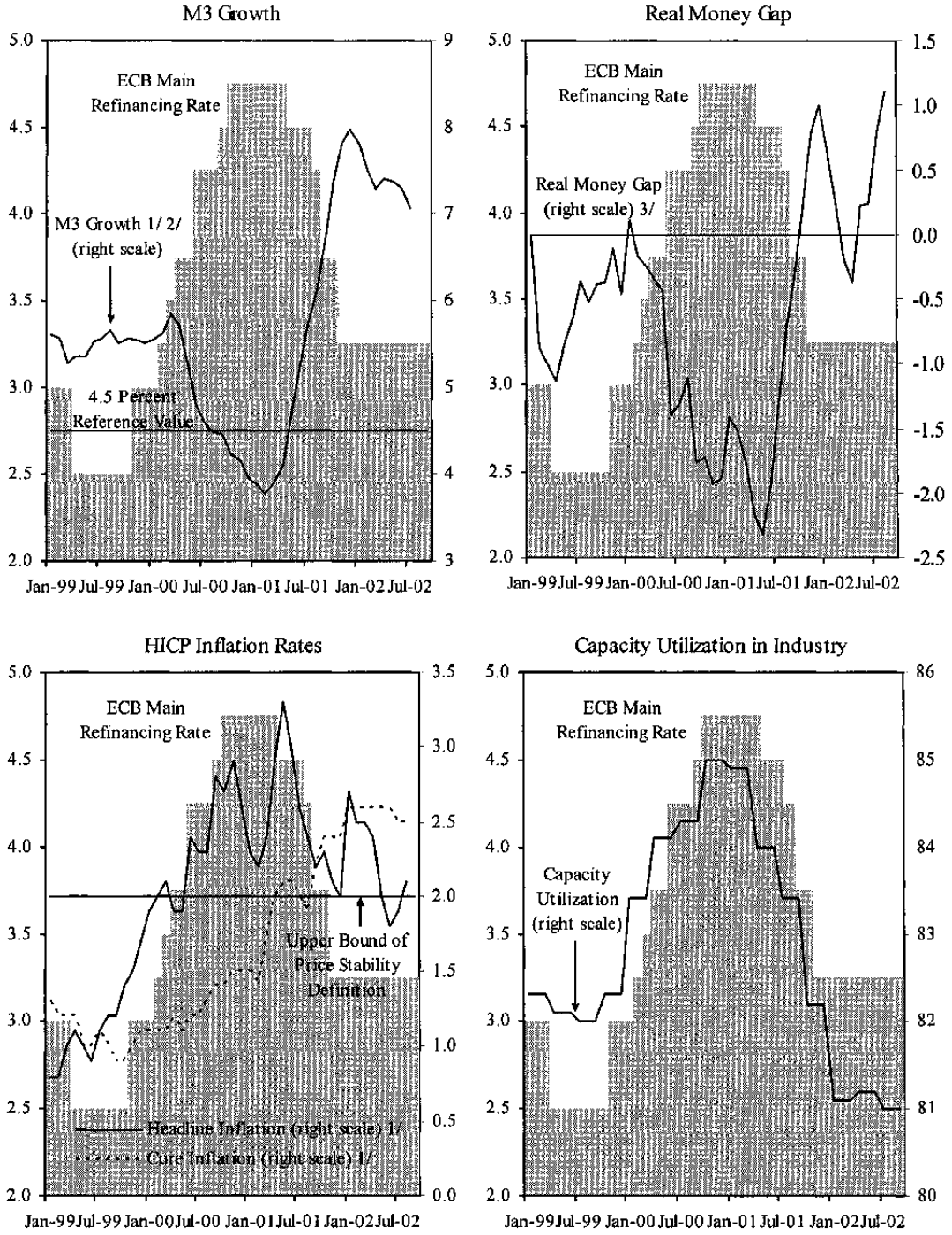
Table 2. Euro Area. Frequency of Over- or Undershooting of Symmetric Inflation Target Range for Different Combinations of ϕ and σ_η[1]

ϕ	σ_η			
	1.00	0.75	0.50	0.25
0.90	0.66	0.56	0.38	0.08
0.75	0.51	0.38	0.19	0.01
0.50	0.38	0.25	0.08	0.00
0.25	0.33	0.20	0.05	0.00
0.00	0.32	0.18	0.05	0.00

Source: Staff estimates.

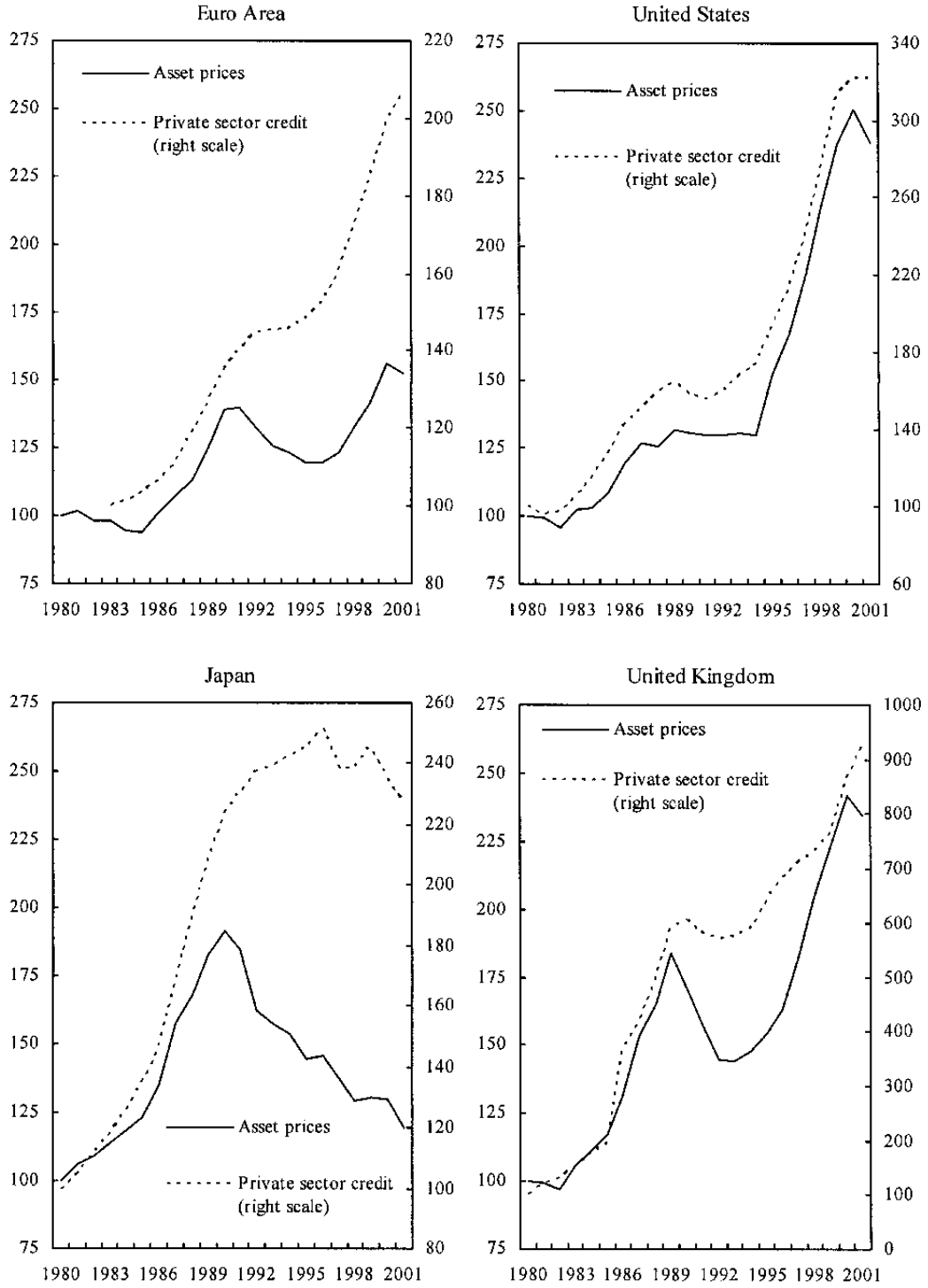
[1]Symmetric inflation target range of 1 percent; the frequencies are based on the assumption that inflation shocks are normally distributed.

Figure 1. Euro Area: ECB Main Refinancing Rate and Monetary Policy Indicators
(In percent)



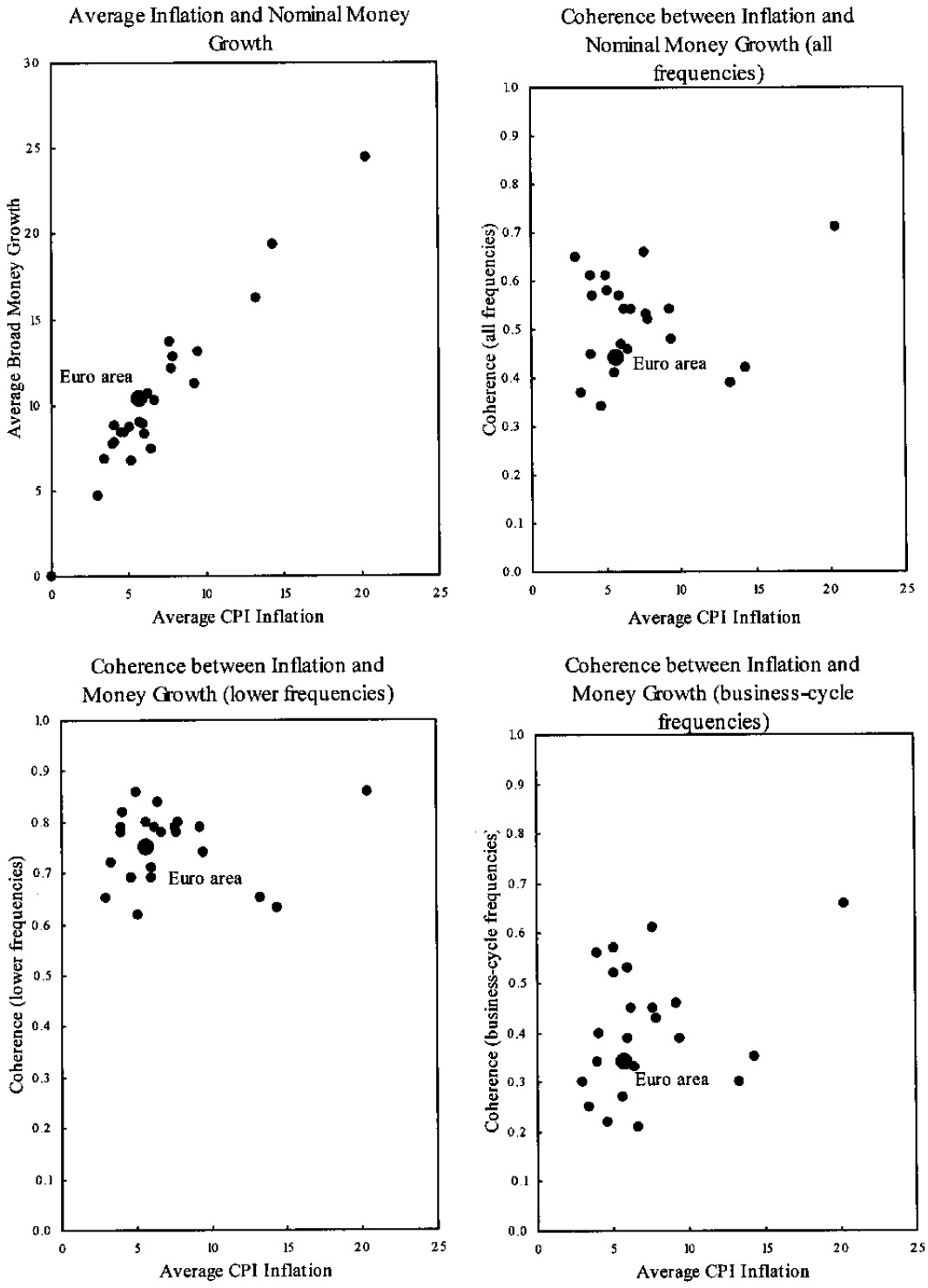
Sources: Eurostat; European Central Bank; Bloomberg; IFS, IMF; and staff estimates.
1/ Year-on-year percent change.
2/ Three-month centered moving average.
3/ Deviation of the actual real stock of M3 from an estimate of the long-run real stock of M3 consistent with long-run inflation of 1.5 percent per year and assuming that the real money gap is zero in January 1999.

Figure 2. Real Asset Prices and Real Private Credit (1980=100) 1/



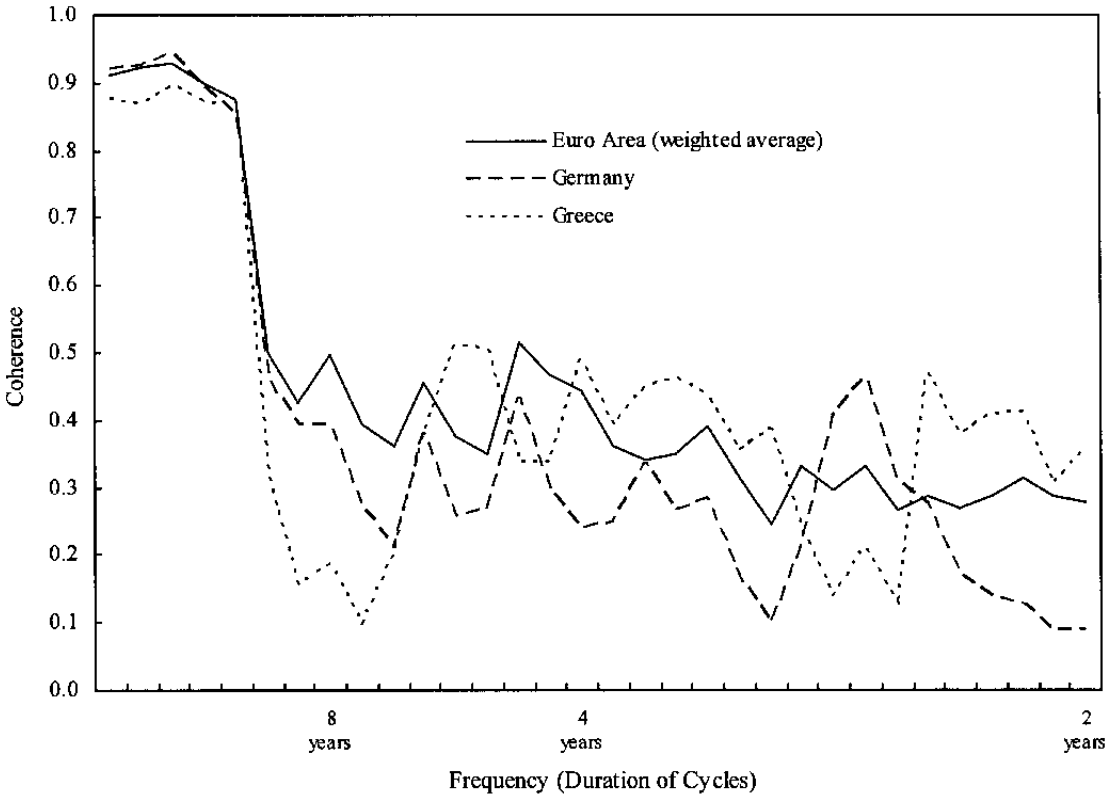
Sources: Bank for International Settlements (BIS); IFS, IMF; and staff calculations.
1/ Assets include equities, residential real estate, and commercial real estate (inflation-weighted index 1980=100); euro-area data are based on BIS data for Germany, France, Italy, Spain, the Netherlands, Belgium, and Finland.

Figure 3. Money and Inflation in Industrial Countries, 1961-2000 1/



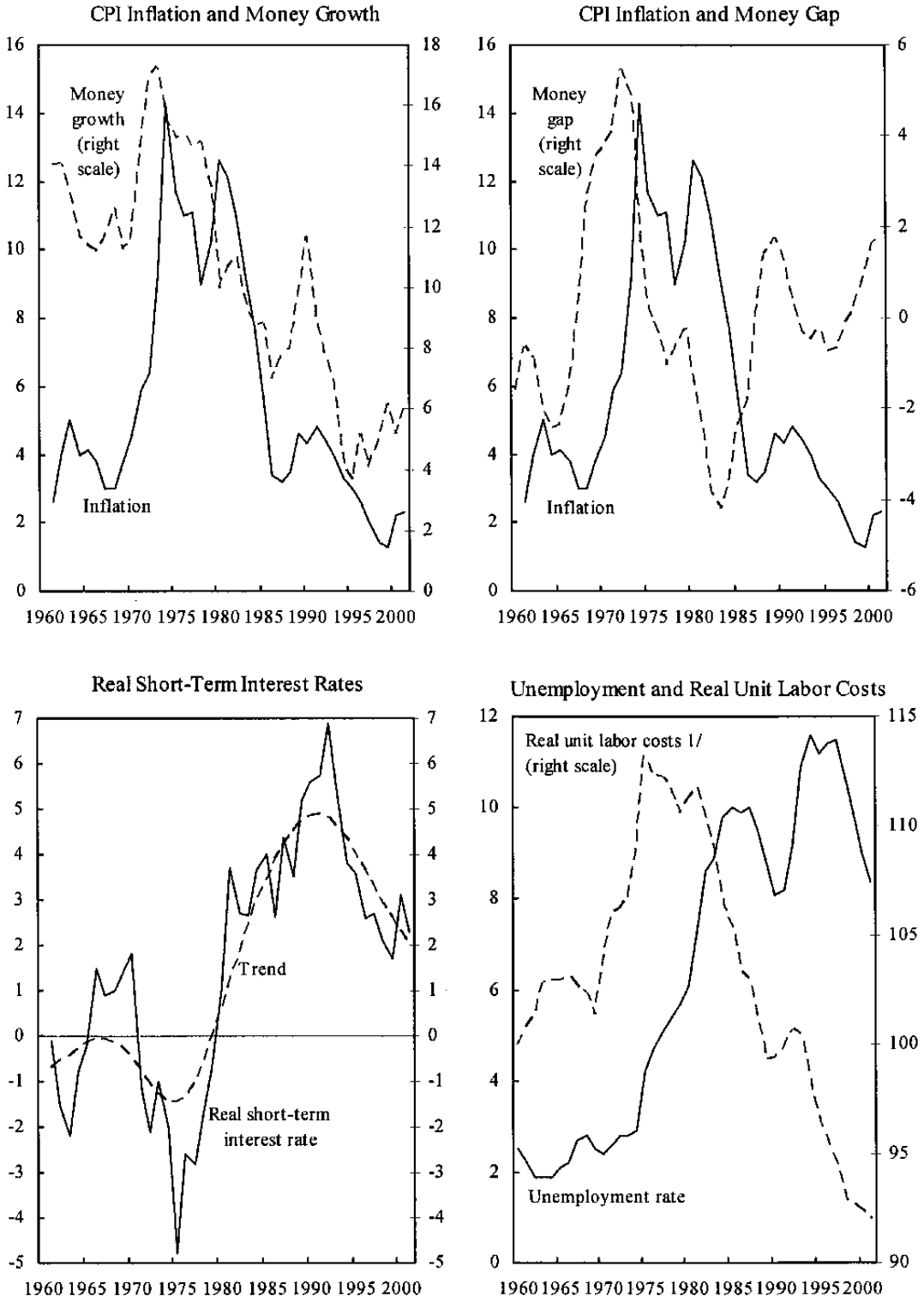
Sources: European Commission; WEO, IMF; IFS, IMF; and staff calculations.
1/ Data for the euro-area countries end in 1998.

Figure 4. Coherence Between Money Growth and Inflation, 1961-98



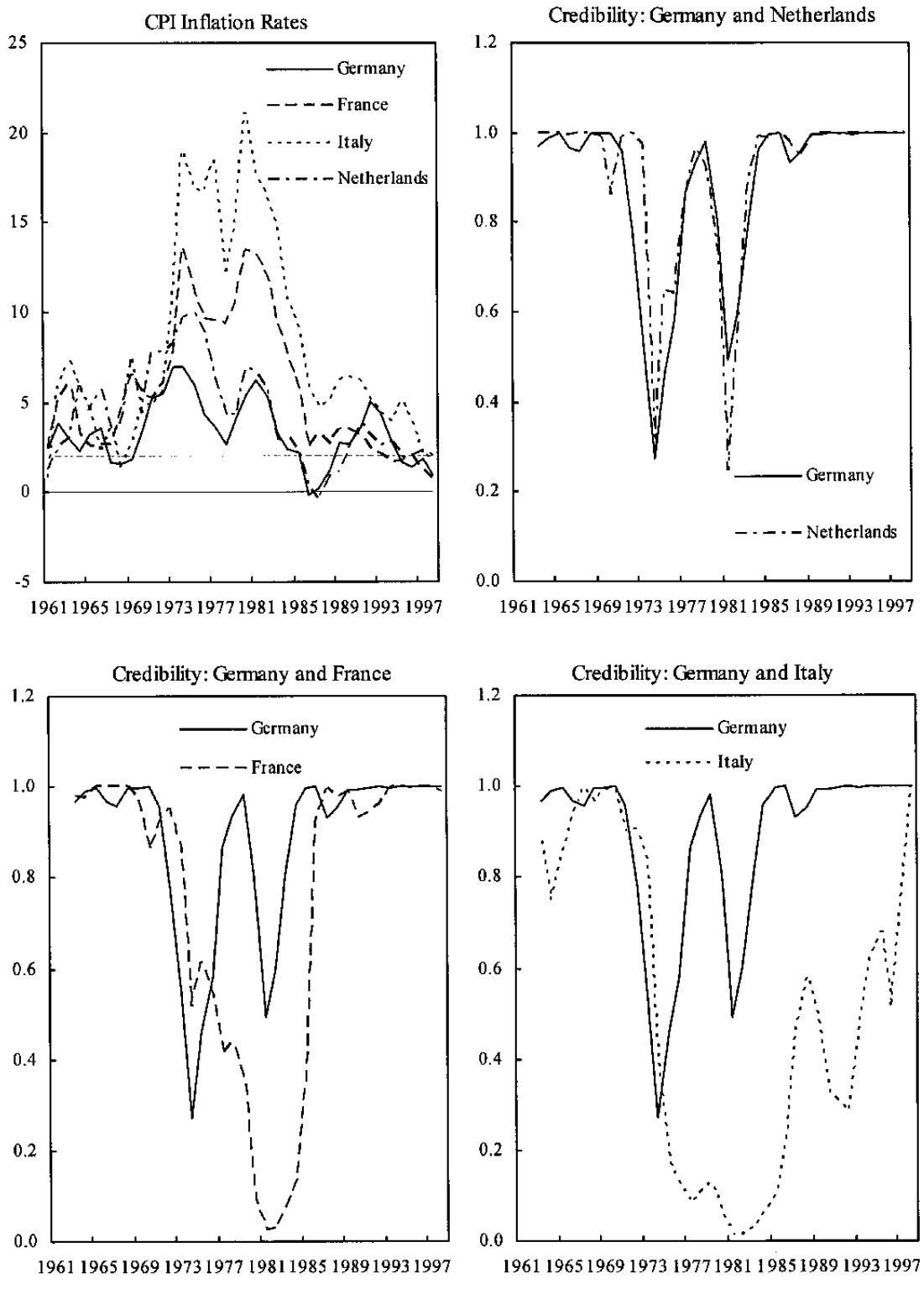
Sources: European Commission; WEO, IMF; IFS, IMF; and staff calculations.

Figure 5. The Euro Area's Monetary and Inflation Experience, 1960-2001
(In percent)



Sources: European Commission; and staff estimates.
1/ Index, 1960=100.

Figure 6. Central Bank Credibility, 1961-98



Sources: European Commission; and staff estimates.

III. Market Predictability of ECB Policy Decisions: A Comparative Analysis[1]

A. Introduction

1. Particularly during it's early history, many surveys and reviews of the European Central Bank's (ECB) monetary framework emphasized the inability of financial markets to fully understand and correctly predict monetary policy decisions.[2] According to these reports, market participants questioned the ECB's degree of policy transparency and had difficulty interpreting how the two-pillar monetary framework was linked to policy actions.[3] At the same time, these surveys of financial market participants gave relatively high marks to the United States Federal Reserve (Fed) and the Bank of England (BoE) on their ability to be understood by financial markets.

2. In various communications the ECB has highlighted the important linkage between financial markets ability to understand and predict monetary policy decisions and the effective implementation of monetary policy.[4] In an address to an *ECB Watchers Conference,* Issing (2001) noted that policy "should induce 'rule like' behavior on the behalf of market participants. This leads them to react to new developments in a manner consistent with the monetary policy strategy, thus aiding in the smooth conduct of monetary policy." Similarly, Hämäläinen (2001) stressed that "a credible and predictable central bank can achieve price stability with more stable interest rate movements and at lower interest rate levels than a central bank with lower credibility".

3. So far, empirical research by the ECB has indicated that financial markets have generally understood and predicted ECB policy decisions since the startup of Stage III of EMU (Box 1). Most of this work, however, has focused on a relatively small number of ECB policy decisions or during a period of generalized expectations of tightening. Research on the predictability of Federal Reserve and BoE's Monetary Policy Committee (MPC) policy actions has tended to support a view of an evolving process: as transparency and market understanding of policy have increased over the years, the accuracy of market forecast's of central bank policy decisions has improved. For example, Haldane and Read (2001) found that the introduction of inflation targeting in the U.K. appears to have coincided with a marked dampening in yield curve responses, suggesting greater transparency and

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[1] Prepared by Kevin Ross (kross@imf.org).

[2] See Begg et.al., (2002), Bini-Smaghi and Gros, (2001), Blinder, et.al., (2001), and Callow (2001).

[3] Gros, et.al, (2002) indicate that predictability may have improved since the second half of 2001.

[4] However, there may be instances of justifiable monetary policy surprises, e.g., during periods of asymmetric information.

predictability as the BoE monetary framework changed. For the U.S., Poole and Rasche (2001) demonstrated that predictability of the Fed's actions increased after the 1994 decision to announce changes in Fed policy rates immediately after Federal Open Market Committee (FOMC) meetings.

4. Against this background, this paper examines the predictability of the ECB, BoE and U.S. Fed's monetary policy decisions over the last 3½ years. A comparison of policy actions during this period offers a number of advantages, including the ability to examine central bank predictability of two industrial countries and a currency union, each with distinctive monetary frameworks, during a number of large changes in policy rates, and over a period of relatively turbulent shifts in the macroeconomic environment.

5. The paper will rely on calculations that market participants employ in anticipating policy changes and on regressions that provide ex post evidence of market surprises. For a variety of reasons a *direct* comparison of market predictability of these three central banks' policy actions is not feasible. Monetary policy operations and the market instruments available to ascertain expectations of future policy decisions are markedly different between the three central banks (Figure 1).[5] Therefore, different degrees and types of liquidity, term and risk premia may be affecting the outcomes under the simple techniques employed in this study. Other factors, which prevent precise conclusions, are differences in macroeconomic environments and the short period of time under review—with a restricted number of policy decisions—that limit the power of the empirical work undertaken.

6. The rest of the paper is organized as follows: section B briefly discusses the recent evolution in how these three central bank's communicate their monetary policy stance. Sections C and D describe the policy decisions undertaken during the period under review and estimates the degree to which each central bank followed a pattern of interest rate smoothing. Section E presents the results of our predictability analysis of central bank policy decisions, while in section F, the outcomes of regressions that examine the movement of yield curves at the time of policy rate changes are discussed. Finally, some concluding observations are offered in section G.

B. The Movement Toward Greater Transparency of Central Bank Policy Actions

7. Monetary policy has it's greatest impact on current economic conditions and the movement of financial market variables through the formulation of expectations. Indeed, the efficacy of the monetary transmission mechanism—the link between the real economy and policy—depends heavily on the ability of monetary policy to impact the course of interest

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[5] For example, a futures contract on Federal Funds—the main policy rate of the U.S. central bank—is available while futures contracts on the euro-area's two-week official repo instrument are non-existent. See Borio (1997, 2001), and Blenck, et.al. (2001) for a comparison of monetary policy operating procedures and frameworks.

rates through financial market expectations. With this in mind, many industrial country central banks in the 1990s embraced a greater emphasis on transparency and open communication in order to enhance credibility and improve the effectiveness of policy.

8. Historically, the conduct of U.S. monetary policy has been viewed as rather opaque. For example, before February 1994 changes in policy rates were not announced but rather left to be gradually discerned by financial markets. However, since then the U.S. Federal Reserve has started to publicly announced FOMC policy changes, with this policy officially enshrined in 1995. In a similar vein, before May 1999, press statements announcing policy decisions were relatively brief, cryptic, and undifferentiated between rate cuts and rate increases. Now, these statements offer greater detail on all policy decisions, and occur after every meeting. In addition, prior to May 1999, the Fed would announce its "policy bias" only after FOMC minutes were published (a few days after the next meeting) thus disabling it's signaling function. Since then, the policy bias has been announced immediately after each FOMC meeting making it an effective forward-looking signal. In February 2000, the Fed moved away from the policy bias terminology and instead inserted a formulaic "balance of risks" sentence in order to clarify its asymmetric directives regarding inflationary pressures and economic weaknesses.[6] Finally, in March 2002, the FOMC started to publish a roll call of the votes on the Federal Funds target, including the preferred policy choice of any dissenters.

9. Most of the changes in communication and transparency at the Bank of England can be linked to the granting of operational independence in May 1997. At that time, the setting of monetary policy was delegated to the MPC , with the power to set the inflation target remaining with the Chancellor. In addition, the BoE's *Inflation Report*—christened in 1993—was retained as the main public communication vehicle that described current MPC thinking. While press statements on policy decisions have shied away from a precisely worded statement on the balance of risks to the inflation target—due in some part to the individualistic nature of the MPC—the quarterly inflation report contains a rather detailed analysis of the balance of risks and highlights financial market's views on these risks. Most of the MPC's analysis is encapsulated in error bands or probability distributions contained in fan charts on the direction of prices and output some 2-years ahead. Also, these fan charts are published under constant as well as expected market interest rates. For MPC members, one gap in coverage may arise from the fact that these charts are only updated on a quarterly

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[6] In August 1999, the FOMC established the *Working Group on the Directive and Disclosure Policy* to assess the FOMC's approach to disclosing its view about prospective policy adjustments and to propose procedural modifications. The working group's January 2000 report recommended that the FOMC statement issue a "balance-of-risks" statement that chose between a set of bracketed words to reflect the Committee's view about prospective developments. Now risks are explicitly categorized as either: (i) balanced with respect for both goals; (ii) weighted mainly toward conditions that may generate heightened inflation pressures; or (iii) weighted mainly toward conditions that may generate economic weakness.

basis versus a monthly MPC meeting. Finally, the BoE publishes the minutes of each MPC meeting with a 2-week lag and has outlined in some detail, the models used by the Committee.

10. In many respects, the ECB has been able to draw upon this new emphasis on transparency and openness when it developed its communication and disclosure policies. Like many other central banks with a defined inflation objective, the ECB issues a *Monthly Bulletin*, which provides a relatively detailed analysis of monetary and economic developments throughout the area. The monthly editorial in the bulletin offers a guide to the Council's assessment of the balance of risks to price stability and the suitability of its monetary policy stance.[7] In addition, after the first meeting of the month, the President and Vice-President preside over a press conference, in which an introductory statement—that will be used as the outline of the editorial of the next bulletin—is read out and the floor opened to questions and answers.

11. At the same time, the ECB has augmented or modified some aspects of its communication strategy over the last 3½ years. First, since December 2000 the ECB has started to publish bi-annual staff forecasts on output growth and inflation, which are discussed in the monthly bulletin.[8] However, the models and methods that underlie these forecasts are not explicitly presented in detail, and it is unclear how much weight the Governing Council actually places on them in formulating policy. Second, in November 2001 the ECB moved from bi-monthly meetings of the Governing Council, at which time interest rate decisions are undertaken, to monthly meetings.[9] At the second meeting of the month, the Governing Council focuses on issues related to other tasks and responsibilities of the ECB and Eurosystem. Finally, since 1999 ECB's Governing Council has actively

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[7] While the language used in the press statement (and editorial) has generally referenced the "balance of risks to price stability over the medium-term", the presentation of this assessment has not been uniform since the start of stage III of EMU. For example, in the Fall of 1999 President Duisenberg talked about "creeping biases" during press conferences; beginning in May 2001 editorial statements regarding the "appropriateness" of policy rates over the medium-term were used; in May 2002 the editorial compared the balance of risks to those projected in December 2001; and in June 2002 the editorial noted that there was too much uncertainty to fully assess the balance of risks.

[8] These staff forecasts, however, have been criticized for their lack of precision. The width of forecast error bands have been set at twice the historical mean absolute forecast errors made by euro-area central banks.

[9] President Duisenberg noted that bi-monthly meetings had led to higher volatility in exchange rates and interest rates, and the move to assess monetary policy only at the first meeting of the month may have the effect of calming markets, (ECB Press Conference, November 8, 2001).

supported and participated in a unique annual forum for ECB watchers that brings together academics, the media and financial market participants in a broad discussion on ECB policy.

C. ECB, Fed, and BoE Policy Decisions

12. Table 1 displays information on monetary policy decisions of the ECB, U.S. Fed and BoE over January 1999 to May 2002 period. All three central banks hold frequent, regularly scheduled monetary policy meetings. With bi-monthly policy meetings—until the move to monthly meetings in February 2002—the ECB Governing Council has met more often, some 77 times over the 41-month period versus 30 and 42 meetings respectively, of the U.S. Fed's Federal Open Market Committee (FOMC) and the BoE's MPC. In general, it would appear that the ECB has been the least active central bank with only 16 percent of all meetings resulting in a decision to change policy rates. On the other hand, the U.S. Fed has been the most active, changing the targeted Federal Funds rate at about 60 percent of the FOMC decision dates, while the BoE's policy activism lies in-between, moving repo rates at about 35 percent of all MPC meetings.

13. However, the more frequent ECB Governing Council meetings may provide a false sense of inactivity. Excluding the non-scheduled September 17, 2001 meeting, the ECB has tended to change rates at the very end or beginning of the month (9 of the 11 changes) when all available monthly information on activity and prices have been tabulated suggesting that mid-monthly meetings would not be expected to contain changes in policy stance. Similarly, there have been three U.S. Fed policy changes during unscheduled meetings (through telephone conference calls among the FOMC) that increase the percentage of Fed policy activism.[10] Also, the Federal Reserve was much less active in the preceding 40 policy meetings from 1994-98, changing rates only 30 percent of the time, suggesting the last three years has been a particularly active period in US monetary policy.

D. Interest Rate Smoothing and Predictability

14. Generally, the three central banks appear to favor a form of interest rate smoothing, with small movements in interest rates without marked reversals in direction. In fact, including the path of rates in the pre-1999 period, each central bank changed direction of interest rates twice over the last 3½-4 years, with only two of the six directional changes applying rate changes of at least 50 basis points. In addition, the time lag between the last policy move and the new change in direction policy move has usually been about

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[10] Eliminating the three change decisions during these non-scheduled meeting days would decease Fed activism to some 50 percent of all FOMC meetings over this period. The Fed meets 8 times a year with the first and fourth meeting held over two days in order to cover the longer-term economic outlook and current state of open market operations. There does not appear to be any pattern regarding the decision to change rates. The BoE's MPC generally meets on the Wednesday and Thursday after the first Monday of the month.

9-11 months. Interest rate smoothing has typically been explained by uncertainty regarding the current state of the economy, with policymakers undertaking a rather muted reaction to new data since the true structure of the economy is unknown.[11] Interest rate smoothing behavior under this scenario could be uncovered by looking at basic autocorrelations.

15. An alternative explanation focuses on the use of a systematic and *predictable* monetary policy (with low nominal interest rate variability) in the context of a forward-looking private sector. In this view, the potency of monetary policy will be enhanced—through the formation of accurate expectations of future policy—if the private sector can expect interest rate changes to persist, allowing agents to better anticipate policy adjustments. This can be accomplished if the central bank commits itself to a rule.[12]

16. To quantify the extent to which each central bank has followed an interest rate smoothing policy (and therefore tended to improve the probability of accurate market predictions), we estimated the following regression on monthly data (1999.1-2001.12) for each area:

$$i_t = \alpha + \beta\pi_t + \gamma gap_t + \lambda i_{t-1} + \varepsilon_t \qquad (1)$$

where i_t is the overnight interest rate series, π_t is the CPI inflation rate, gap_t is detrended industrial production, and i_{t-1} is the one-period lagged overnight interest rate. This type of regression separates out an explicit smoothing coefficient (λ) from other factors that may have affected the behavior of the monetary authority. Larger values of (λ) imply a higher degree of smoothing.

17. Figure 2 shows the behavior of these overnight interest rates and the estimated smoothing coefficient. The smoothing coefficients for the euro area and the U.K. are very similar at around 0.8. For the U.S., the smoothing coefficient is greater than one, indicating that shocks affecting the setting of interest rates would not eventually fade away, i.e., interest rates would not revert to "trend". Previous work by Amato and Laubach (1999) estimated an interest rate-smoothing coefficient of about 0.9 for the US using data from the late 1980s to 1997. Thus, our results imply that Federal Reserve's view of the economy, perhaps related to the signals emanating from the equity markets, radically changed in 2001, forcing the Fed to abandon the small infrequent changes seen under interest rate smoothing in favor of repeated

[11] See Brainard (1967).

[12] Given that policy moves are expected to last well into the future, consumers and firms should react more forcefully today to any change in policy rates.

large reductions in the Fed Funds target.[13] This should make the predictability of U.S. policymakers more difficult in comparison to the U.K. and the euro area.

E. Predictability of Central Bank Interest Rate Decisions

18. Given the paper's focus on the relative predictability of ECB policy decisions, benchmark calculations on how well financial markets anticipated U.S. Fed and BoE policy actions are undertaken first. The results on ECB policy decisions is then compared to the evidence for these two central banks.

The U.S. Federal Reserve FOMC

19. This section uses Fed Funds futures rates to predict changes in U.S. monetary policy. In doing so, we follow the heuristic method employed by Robertson and Thornton (1997). Variants of this method have been used by Poole and Rasche (2001) and Kuttner (2000) in studies of the expected and unexpected changes in Fed Funds targets.

20. We start by assuming that the one-month Fed Funds futures rate is a predictor of average Federal Funds rate, with the allowance for a non-zero risk premium α_i that may vary with the forecast horizon. Specifically,

$$fff_{t,i} = E_t \overline{ff}_{t+i} + \alpha_i \qquad (2)$$

where $fff_{t,i}$ is the i-month ahead future rate calculated as the rate on the last day of the month, E_t the expectations operator at time t and $\overline{ff}_{t+i}$ is the average of the daily effective federal funds rate for each day of the month. The data are measured on a monthly frequency, and given that our data runs from January 1999 to May 2002, we have 41 observations. The forecast errors are serially correlated, and adjusted estimates reveal a significant positive bias of 8.3 basis points at the one-month horizon. This "hedging premium" results from the fact that banks use the Federal Funds market to finance their loan portfolios and will hedge their positions against any rate increases in the futures market. The desire to protect against possible spot increases will increase the yield in the futures market.

21. Using the one-month Fed funds futures rate at the end of the month as a barometer of expected changes in the Fed funds target over the following month runs into two problems. First, the Fed funds futures rate is a forecast of the average of Fed funds rates and not the Fed funds target. Second, the effect of a target change on the average depends on the timing and the magnitude of any target change.

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[13] Approximately 53 percent of the U.S. Federal Reserve changes in interest rates in this 3½-year period were at least as large as 50 basis points. For the ECB and the BoE, these figures are 42 and 13 percent, respectively.

22. Assume the market's forecast of the average funds rate is the sum of the average Fed funds rate target and deviations of the average Fed funds from that average target:

$$E_t \overline{ff}_{t+i} = E_t \overline{fftar}_{t+i} + E_t(\overline{ff}_{t+i} - \overline{fftar}_{t+i}) \tag{3}$$

Substituting from equation 2, we get:

$$fff_{t,i} - \alpha_i = E_t \overline{fftar}_{t+i} + E_t(\overline{ff}_{t+i} - \overline{fftar}_{t+i}) \tag{4}$$

Thus, the bias adjusted futures rate would deviate from the market's forecast for the average target rate when the market's forecast for the average Fed funds rate differs from the average target rate. In order to identify the market's expectation for the target rate, we could assume that the market's expectation of the average Fed funds rate will coincide with the Fed Funds target rate. However, this is unlikely, so identification remains a problem.

23. Robertson and Thornton consider a "partial identifying assumption", which allows identification on occasions when the market is expecting a change in the target rate. Specifically, assume that $E_t(\overline{ff}_{t+i} - \overline{fftar}_{t+i})$ falls within a certain interval. If the bias-adjusted i-month spread between the futures rate and current target rate is outside this interval then they conclude the market expected a change in the target. To see this better subtract $fftar_t$ from both sides of equation 4 to get:

$$fff_{t,i} - \alpha_i - fftar_t = E_t \overline{fftar}_{t+i} - fftar_t + E_t(\overline{ff}_{t+i} - \overline{fftar}_{t+i}) \tag{5}$$

24. If markets expected no change in the target, the bias adjusted spread between the Fed funds futures and the target is equal to the market's expectation of the average Fed funds-Fed target spread, i.e., the historical average spread.

$$fff_{t,i} - \alpha_i - fftar_t = E_t(\overline{ff}_{t+i} - \overline{fftar}_{t+i}) \tag{6}$$

This partial identifying assumption can be made operational by using the min/max bounds of $(\overline{ff}_{t+i} - \overline{fftar}_{t+i})$ over the whole sample period. In our sample, this has ranged between –20.4 and +5.9 basis points. With the interval determined, we then plot the bias adjusted spread $(fff_{t,i} - \alpha_i - fftar_t)$, with points outside the interval signifying an expectation of a target change (Figure 3, top panel).

25. To compare against actual changes in the Fed Funds target, we plot as vertical bars the difference between the current Fed Funds target and the average of the following

month.[14] The results show that futures markets did not emit false signals regarding rate increases and were able to predict most of the rate increases in 1999 and 2000. The two exceptions being the 25-basis point increases of November 1999 and February 2000. Most importantly, the markets were able to predict changes in direction (both the increase in rates in 1999 and the reversal in 2001) and anticipated the majority of the large changes in rates. However, the markets did not anticipate well the last round of sharp cuts starting in September of 2001, perhaps due to the aforementioned deviation from interest rate smoothing. In fact, two-thirds of the errors in market anticipation of Fed policy action can be found in the fall of 2001.

26. The accuracy of the forecast results can be summarized in a basic tabulation, Table 2. The simple rule correctly predicted 10 out of the 16 (63 percent) Fed funds target changes and 100 percent of the no-change months.[15] While the overall hit rate was about 85 percent, with 35 of the 41 months correctly predicted, the reliability of the model's prediction of a policy change was 100 percent or 10 out of 10. However, it is important to remember that this analysis predicts monthly FOMC policy actions (over our 41-month sample), regardless if a meeting had been scheduled. In 11 months, no policy decision meetings occurred within the month. Although the model correctly predicted no target changes during these months, eliminating these dates would bring the overall hit rate to some 80 percent (24 out of 30 decisions).

27. A second caveat is the use of the range of the prediction interval. We made the model operational by using the min/max bounds of $(\overline{ff}_{t+i} - \overline{fftar}_{t+i})$ over the whole sample period. These bounds were influenced by rather large end-of-year values; adjusting for these values resulted in a min/max range of –9.8 to +5.9 basis points. Re-tabulating the contingency table under the adjusted bands resulted in very similar numbers. The model predicts 11 out of the 16 policy rate changes and 20 out of the 25 no-change months. The overall hit ratio falls to 31 out of 41, or 76 percent, while the reliability of a change prediction falls to 69 percent or 11 out of 16. In sum, given that the accuracy of a no-change forecast was around 40 percent, it is clear that the markets, as embodied in the futures markets data, do a fair job of predicting policy decisions of the US Federal Reserve's FOMC.

The BoE's Monetary Policy Committee

28. Money market instruments available to extract expectations of future changes in the Bank of England's (BoE) official two-week repo rate include: (i) generalized collateral (GC)

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[14] In order to allow rate hikes to be shown as positive changes, we take the negative of the spreads. Similarly we reverse the min/max range in what follows.

[15] Two rate moves were undertaken in January 2001, which are considered as one monthly move in the analysis. Thus the 17 policy moves tabulated in Table 1 must be considered as 16 policy moves.

repurchase agreements, (ii) interbank loans fixed at LIBOR rates, (iii) short-sterling futures contracts, (iv) forward rate agreements (FRAs), (v) the sterling swap market, and (vi) the sterling overnight interest average (SONIA) deposit rate. However, in each instrument the existence of term premia, and differences in credit quality, maturity, liquidity and other biases complicate the extraction of a "pure measure" of market expectations.[16]

29. Recognizing the inability of any one money market instrument to provide the best indication of Bank repo rate expectations, the BoE estimates two alternative forward curves from two alternative sets of instruments, each with common credit risk characteristics. One curve is fitted using mostly GC repos and gilt yields (known generically as the VRP[17] curve), while the second (known as the Bank Liability Curve) is fitted using synthetic bond prices from interbank offer rates, short-sterling futures, FRAs and swaps. After adjusting for biases, these curves can be seen as the best measure of the market's expectation of two-week forward rates. In what follows, we focus on market predictability taken from the short-end of VRP curve since it resulted in slightly better results.[18]

30. In order to determine the degree of predictability of BoE policy decisions, the interest rate from the fitted VRP curve is defined as a linear combination of two events:

$$i_t = \beta i_{25} + (1-\beta) i_0 \tag{7}$$

where β is the probability of at least a 25 basis point change and $(1-\beta)$ is the probability of a no change decision. The interest rates are the present BoE official two-week repo rate with a 25 basis point change i_{25} added on and the current official rate i_0. The assumption is that a β of 50 percent or greater implies the market expected the BoE to change interest rates during the upcoming MPC meeting. The observations are taken the day before the two-day meeting of the Bank's MPC[19]. In the analysis, 42 meetings are used, 1 more than in Table 1 given the two meetings in September 2001.

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[16] See Brooke, Cooper, and Scholtes (1999), "Inferring Market Interest Rate Expectations from Money Market Rates", Bank of England, Quarterly Bulletin.

[17] The BoE uses a variable roughness penalty (VRP) technique to fit various types of forward curves.

[18] Near-term 3-month short sterling futures contracts were used. This method relied on more judgmental calculations of the time-varying term premia between the 3-month interbank deposit rate and the official repo rate, and resulted in somewhat less satisfactory outcomes. These results are available from the author upon request.

[19] The BoE supplied the data for both curves.

31. Figure 3 (middle panel) reveals in graphical form the number of times financial markets correctly anticipated BoE decisions:

- The graph shows that the two 50 basis point cuts in interest rates (February 1999, and November 2001) were anticipated by the market but the first change in direction (September 1999) caught the market off guard.

- In contrast to the U.S. Federal Reserve results, about a third of the incorrect signals can be found in and around the fall of 2001.

- The chart also demonstrates that the lull before the second change in direction—and the move toward loosening policy rates in early 2001—was also correctly viewed by markets as a "wait and see" period.

32. The contingency table results (Table 3) reveals that the simple rule correctly predicted 9 out of the 15 (60 percent) changes in the BoE policy rate and 83 percent of the no-change months. While the overall hit rate was about 71 percent—with 30 of the 42 decisions correctly predicted—the reliability of the model's prediction of a policy change was slightly lower at 60 percent or 9 out of 15.

The ECB Governing Council

33. In this section, we follow the simple heuristic methodology of Gaspar, Pérez, and Sicilia (GPS), who examined the ability of euro-area overnight interbank to anticipate changes in ECB policy rates. Pérez and Rodríguez (2001) showed that without market frictions and with risk neutral participants, euro-area interbank funds within a reserve maintenance period (and with a reserve averaging provision) could be considered perfect substitutes. In this framework, any expected differences between current and future cost of funds would be arbitraged away. Thus, EONIA rates at the start of any reserve maintenance period theoretically should already incorporate expectations of changes in overnight rates until the end of the reserve maintenance period. At the same time, new information could influence rates between the start of the reserve maintenance period and the day of the Governing Council meeting. Thus, the analysis could also be run using EONIA rates the day before the Governing Council meets.[20]

34. With this in mind, EONIA overnight rate before ECB decisions on monetary policy can be viewed a linear combination of two events as in equation (7). However, here the interest rates involved are the present main refinancing operation (MRO) rate with a 25 basis point change i_{25} and the current MRO rate i_0. Again, assuming that a β of 50 percent or

[20] As in GPS, we eliminate meetings that fall within 4 days of the end of the reserve maintenance period to avoid liquidity effects.

greater implies the market expected the ECB to change interest rates, we can evaluate the number of times financial markets anticipated ECB decisions.[21]

35. Figure 3 (bottom panel) presents the results in graphical form using thresholds of +/- 0.125 basis points to represent EONIA outcomes with at least a 50 percent probability of a change in the official MRO rate. Bars are used to show the size and direction of the change in interest rates. With 12 of the 77 meetings close to the end of the reserve maintenance period, we have 65 usable observations. The chart clearly highlights a number of conclusions:

- Although the October decision to reverse the April 1999 50 basis point cut was anticipated by markets, the second change in direction in May 2001 caught the markets by surprise;

- Financial markets were unable to anticipate any of the 5 ECB rate cuts over the last 3½ years;[22]

- Two of the five large rate changes were expected, although in one case (June 2000), it would appear that financial market participants were looking for a smaller 25 basis point change;

- About one-third of the market prediction errors in anticipating ECB policy actions appear in and around the fall of 2001.

36. The contingency table results (Table 4) reveals that the market correctly predicted 7 out of the 12 (58 percent) changes in the ECB policy rate and 83 percent of the no-change months. While the overall hit rate was about 79 percent—with 51 of the 65 decisions correctly predicted—the reliability of the model's prediction of a policy change was only 44 percent or 7 out of 16.

37. Finally, Table 5 provides a summary of the results across all three central banks. The overall result is that the number of correct signals regarding policy decisions were roughly equal across all three central banks. The majority—about four fifths—of the policy decisions of these three central banks have been correctly anticipated by financial markets. However, on the basis of the models used here, the ECB is less predictable as regards large changes in or decreases in rates.

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[21] The average spread between EONIA and MRO rates will vary based upon a (time-varying) risk premia associated with the cyclical expectations of interest rates. Thus, as in GPS, we undertook the analysis with a "structural" spread of 3, 5, and 7 basis points. The outcomes were broadly similar, and here we report results using the 3 basis points spread.

[22] This result also holds when the analysis used EONIA rates at the beginning of the reserve maintenance period.

F. Interest Rate Changes: A View from Shifts in Yield Curves

38. Evidence on the predictability of central bank policy decisions can also be discerned from movements in the term structure of interest rates. From an expectations perspective, each point on the yield curve represents private sector agents' best guesses on the current and future path of official interest rates. In forming these expectations, two sources of policy reaction uncertainty can arise. The first is related to private information on the macroeconomic indicators used by monetary authorities reaction function or in the monetary transmission process itself. Surprises here would reveal themselves at the short-end of the yield curve, particularly since lags on superior statistical data or monetary transmission mechanism itself is short lived. The second source of uncertainty is current and future (expected) policy targets, which may stem from imperfect policy credibility. This uncertainty on policy credibility could be due to reputation building or to an ongoing discovery process of market participants uncovering the central bank's true policy targets.

39. To extract a measure of interest rate surprises along the yield curve, the following equation was estimated for each area across various maturities:

$$\Delta i_t^m = \alpha + \beta(L)\Delta i_t^m + \theta\Delta i_t^p + \gamma d_t \Delta i_t^p + \varepsilon_t \qquad (8)$$

where Δi_t^m is the change in interest rates of maturity length m; Δi_t^p is the change in the central bank policy rate; d_t is a multiplicative regime shift dummy variable; and ε_t is a random error term.

40. Each regression uses daily data[23] and is based on a set maturity length. Regressions were first run for the pre-1999 period to set baseline reaction levels, and then run over the January 1999 to May 2002 period to see if the reaction of yields changed over the last 3½ years. Yields on changes in German securities and in Bundesbank policy rates are use for the euro area given the lack of a true euro-area benchmark security and the de facto Bundesbank setting of area-wide policy in the pre-ECB period. In the post-1998 period, changes in the ECB two-week repo rate are used to represent changes in the monetary authorities policy stance.

41. Table 6 presents coefficient estimates on the main variable of interest (θ) and Newey-West adjusted p-values for each of the three countries at each maturity. A comparison of the results between the two periods suggests that surprises at the short-end of the yield curve have diminished in the United States and the United Kingdom since 1998. However, the comparison of euro-area and German interest rate data indicates that the surprises at the short-end of the spectrum have increased—between 10 to 20 basis points—since the start of

[23] All data was taken from Bloomberg. Libor rates were used at short maturities. U.K. gilt, U.S. treasury bond, and German bund rates were used at longer maturities.

stage III of EMU. In all cases, there would appear to be very little change at the long-end of the yield curve. Financial markets continue to view all three of these central banks as credible institutions, with well know policy targets.

G. Concluding Observations

42. Together with the general public, media and academic community, financial markets are an important constituency group of any central bank. In particular, although central banks can control short-term interest rates through monetary policy, their control on longer-term yields and asset prices (and therefore the transmission of monetary policy) is somewhat more tenuous, being enacted mainly through the formulation of expectations. In this regard, the stability of expectations—and therefore the effectiveness of monetary policy—can be greatly enhanced if markets are able to anticipate correctly central bank policy decisions.

43. To some market participants, the early record of the ECB has created the impression that financial markets are less able to predict ECB policy decisions, particularly when compared to other central banks. To evaluate the validity of these impressions, this paper has examined the predictability of ECB, BoE, and U.S. Fed policy decisions over the last 3½ years.

44. Any comparison on the predictability of these three particular central banks should acknowledge the rather unique circumstances of the ECB. The ECB is a relatively young institution with a track record of only a few years, which has needed to be mindful of establishing its independence from political influences. In addition, unlike the Fed or the BoE, it must communicate its strategy and decisions to a very diverse constituency covering a variety of countries with distinctive political backgrounds and views on the role of monetary policy. For example, some of the ECB's communication appears to be directed toward price and wage setters, in line with an European tradition that focuses on ensuring wage moderation. An added complexity arises from communicating central bank views on fiscal policy actions, particularly given the rather distinct nature of the Stability Pact framework. These factors, plus the two pillar monetary framework suggests that the ECB may be, a priori, somewhat less predictable than the other two older institutions.

45. The empirical results provide support for a number of conclusions:

- All three central banks are relatively predictable institutions with a high degree of credibility. Through prudent policy management, each institution has helped to achieve low inflation environments, and markets appear to generally understand the policy objectives and frameworks of each central bank with few marked surprises in policy decisions.

- The U.S. Federal Reserve—the most active central bank among the three with over 55 percent of meetings resulting in a decision to change rates—appears to be the most predictable central bank. Broadly speaking, the results on the predictability of the BoE fall in-between those of the U.S. Fed and the ECB. This outcome may be linked

to the small size of the U.K. economy, which is subject to a sizable number of shocks. In such circumstances, the potential for disparate interpretations between the central bank and financial markets on the implications of these shocks may be frequent, the result of which would be reflected in "unanticipated" policy decisions.

- In the case of the ECB, the market has had difficulty anticipating—at least in our calculations—large changes and cuts in policy interest rates. To some extent, this may be due to the large number of Governing Council meetings with no policy changes and the debate about the ECB's monetary framework. A second factor may have been that rate cuts (4 out of the 5) have taken place during periods when the monthly bulletin was indicating a neutral bias in policy rates for the medium-term. The market's mediocre record in predicting cuts in ECB policy rates, however, may be related to a specific characteristic of the euro-area inter-bank market. For example, inter-bank yields may not be able to respond quickly to rate cut signals given the well-known tendency of banks to be short reserves preceding the end of the reserve maintenance period. Thus, additional work on the predictability of ECB policy decisions will need to examine other markets.

- Finally, the finding of a high degree of overall policy predictability among these three central banks during a relatively turbulent period demonstrates that a variety of monetary policy frameworks, be it inflation targeting, a uniquely continental European two-pillar system, or a more discretionary U.S. model can be successfully understood by financial markets.

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Box 1. Research on Predicting ECB Policy Decisions

Two research studies (Gaspar, Pérez, and Sicilia (2001) (GPS) and Hartmann, Manna and Manzanares (2001) (HMM) have considered the market's ability to predict ECB policy moves.[1/] GPS examined the *daily* overnight EONIA market using interest rate data from January 1999 to March 2001. HMM examined *intra-day tick* data (bid-ask spreads and mid-rates) on overnight interbank quotes from 6 voice brokers in four euro-area countries as well as tick data from the Italian electronic trading system (e-MID) from November 1999 to March 2000. Both papers viewed their results as providing positive evidence on the ability of markets to predict ECB policy decisions.

GPS (2001)

GPS estimated an EGARCH model of the daily change in EONIA overnight interest rates with calendar, reserve maintenance period and ECB meeting day dummy variables in the mean and variance equations. Meeting dummies were not found to be significant in the mean equation suggesting that monetary policy announcements did not affect overnight rates, i.e., the market did not make systematic errors with respect to monetary decisions. Similarly, the meeting dummies did not have a significant impact on the variance of returns, especially in relation to other fundamental determinates of market volatility (macroeconomic news, liquidity shocks). In addition, GPS used a heuristic approach to show that markets were able to predict a majority *(around 80 to 85 percent)* of the ECB's interest rate decisions.

HMM (2001)

This paper considered the functioning of the overnight market for funds through a study of *quoting activity* (as well as trading volume where available), *overnight rate volatility* (defined as the average absolute overnight rate change during an intra-day period), and *bid-ask spreads* from broker data.

HMM first examined the intra-week and intra-day behavior of the data, focusing on "normal" days (all business days less the two-reserve maintenance period days and Y2K days). Given the infrequent and irregular pattern of the voice broker data, it is broken up into 3 intervals (8 a.m. to 11 a.m.), (11 a.m. to 2 p.m.) and (2 p.m. to 5 p.m.). The average absolute 3-hour interval change in the overnight rate is about 3-4 basis points. Thursdays are the most volatile (and active) at about 4-7 basis points—but as a whole the market is not very volatile. The main microstructure features are: (i) Mondays—low post-weekend trading and volatility, (ii) Tuesdays—high market activity related to MROs, (iii) Wednesdays—large MID trading volumes related to MRO settlement obligations, and (iv) Thursdays—high volatility potentially related to ECB meeting days. Trading activity took on the usual U-shape—except for Thursdays where the mid-day interval was very high—with lots of activity at the start and end of the day. Volatility and spreads were rather U-shaped as well. Friday was relatively active, as managers tended to close out positions before the long weekend break.

Focusing on *monetary policy related events*, HMM investigated the intra-day patterns of Governing Council Thursdays versus non-Governing Council Thursdays. Activity was (substantially) higher on Council days than on non-Council days. In fact, non-Council days look like post-weekend Mondays. A U-shape trading pattern emerged for the non-Council days, but for the Council days, trading activity picked up in the mid-day period. HMM also look more closely at 45-minute intervals from the Italian MID market. *Activity (volume and quoting)* increased dramatically after the 1:45 p.m. ECB policy announcement; in fact, average volume in the post-announcement period on Council days was 2.5 times larger than on non-Council Thursdays and tick frequency was 4.5 times larger. HMM state that the volumes, however, were not particularly low before the ECB policy announcement—as compared to the non-Council Thursdays. They cited this as evidence that upcoming ECB

[1/] See Gaspar, Vitor, Pérez Quirós, Gabriel, and Jorge Sicilia, 2001, *"The ECB Monetary Strategy and the Money Market,"*ECB Working Paper No. 69; and Hartmann, P, M. Manna, and A. Manzanares, 2001, *"The microstructure of the Euro Money Market,"*Journal of International Money and Finance, Vol. 20, pp. 895-948.

Box 1. Research on Predicting ECB Policy Decisions (Continued)

interest rate decisions were not preceded by substantial asymmetric information, which would have led to adverse select and hence ceasing volumes.

Volatility in both the voice broker and electronic trading system increased on Council days around the 1:45 p.m. announcement period. The finer MID data reveal that most of the increase in volatility was right after the ECB policy announcement. Volatility (mean rate changes) on Council days was on average 3 times higher than the mean 45-minute rate change over a non-Council day, and 10 times larger than the average change on a non-Council Thursday during the same interval. Upon a closer examination of the Italian MID data, the authors concluded that the higher volatility after ECB policy announcements was not a mechanical adjustment to the three ECB rate changes in the data, and that the market was better at anticipating an unchanged ECB policy rate than in anticipating changes in policy rates. In particular, only in one rate increase did the overnight rate move close to the future or post-announcement rate. However, the authors noted that the average 4.6 basis point increase right after the announcement on Council days was relatively small given policy changes. On the other hand, mean returns were probably a lot higher right after the announcement; thus the *average basis point change* would tend to hide this outcome.

Bid-ask spreads were higher on Council Thursdays, especially during the mid-day interval. This could be interpreted as asymmetric information increasing trading costs before ECB announcements, however, the authors pointed to the large market activity and volumes, which suggested continuous informational flows. MID spreads were higher—as compared to non-Council Thursdays—both before and after ECB announcements. When compared to all other days (non-Council, non-MRO settlement days) the authors state that the spreads (during pre and post announcement periods) on Council Thursdays were similar. Together with the information on volumes, trading activity, volatility and spreads, the authors stated that overnight market participants were not subject to large uncertainty regarding ECB interest rate decisions, since they could by and large anticipate the decisions.

Table 1. ECB, FED and BoE Policy Decisions, January 1999-May 2002

	ECB	U.S. Fed	BoE
Central bank policy decisions	77	30	42
No-change decisions	65	13	27
Percentage of no-change decisions	84%	43%	64%
Number of changes	12	17	15
Increased rates	7	6	4
by 25 basis points	5	5	4
by 50 basis points	2	1	0
Decreased rates	5	11	11
by 25 basis points	2	3	9
by 50 basis points	3	8	2
Minimum	2.50	1.75	4.00
Maximum	4.75	6.50	6.25
Range	2.25	4.75	2.25
Changes in direction	2	2	2
Number of decisions on non-scheduled meeting days 1/	1	3	1

Source: ECB, US Federal Reserve and the Bank of England; and staff estimates.
1/ Data includes the decisions on September 11, 2001.

Table 2. United States: Contingency Table Using Federal Funds Futures Rates

	Actual Change	Actual No Change	Predicted Total
Predicted Change	10	0	10
	62.5%	*0.0%*	*24.4%*
Predicted No Change	6	25	31
	37.5%	*100.0%*	*75.6%*
Actual Total	16	25	41
Reliability on changes 1/	**100.0%**		
Overall "hit rate" 2/			**85.4%**

Source: Staff estimates.
1/ Percentage of time model signals rate change and one actually happens.
2/ Percentage of correct signals.

Table 3. United Kingdom: Contingency Table Using VRP Fitted Forward Curve

	Actual Change	Actual No Change	Predicted Total
Predicted Change	9	6	15
	60.0%	*22.2%*	*35.7%*
Predicted No Change	6	21	27
	40.0%	*77.8%*	*64.3%*
Actual Total	15	27	42
Reliability on changes 1/	**60.0%**		
Overall "hit rate" 2/			**71.4%**

Source: Staff estimates.
1/ Percentage of time model signals rate change and one actually happens.
2/ Percentage of correct signals.

Table 4. Euro Area: Contingency Table Using EONIA Rates (Day-before-ECB Meetings)

	Actual Change	Actual No Change	Predicted Total
Predicted Change	7	9	16
	58.3%	*17.0%*	*24.6%*
Predicted No Change	5	44	49
	41.7%	*83.0%*	*75.4%*
Actual Total	12	53	65
Reliability on changes 1/	**43.8%**		
Overall "hit rate" 2/			**78.5%**

Source: Staff estimates.
1/ Percentage of time model signals rate change and one actually happens.
2/ Percentage of correct signals.

Table 5. Summary Results of Central Bank Predictability

	Predictability Statistics									
	Percent no changes 1/	Large rate changes 2/ 3/		Changes in direction 2/ 4/		Percentage of cuts correctly anticipated 2/ 5/		Reliability of changes 6/	Incorrect signals in and around Fall 2001	Overall "hit" rate 7/
ECB	84%	(5)	40%	(2)	50%	(5)	0%	44%	1/3	79%
BoE	64%	(2)	100%	(2)	50%	(11)	73%	60%	1/3	71%
U.S. Fed	43%	(9)	56%	(2)	100%	(10)	60%	100%	2/3	85%

Sources: staff estimates.

1/ Percentage of monetary policy meetings in which the decision not to change rates was undertaken.

2/ Numbers in parentheses represent changes.

3/ Percentage of large rate changes correctly anticipated by financial markets. Large rate changes are defined as 50 basis points or greater.

4/ Percentage of changes in the direction of the interest rate policy cycle.

5/ Numbers in parentheses represent total number of policy rate cuts.

6/ Percentage of time model signals rate change and one actually happens.

7/ Percentage of correct signals over all policy decision days.

Table 6. Estimates of Interest Rate Surprise Effects in the United States, United Kingdom, and Euro Area 1/

	United States		United Kingdom		Germany \ ECB	
	1991-1998	1999-2002	1991-1998	1999-2002	1991-1998	1999-2002
1-month	0.218	0.074	0.574	0.308	0.142	0.346
	(0.004)	*(0.034)*	*(0.000)*	*(0.001)*	*(0.039)*	*(0.000)*
3-months	0.263	0.051	0.402	0.236	0.131	0.253
	(0.000)	*(0.197)*	*(0.001)*	*(0.003)*	*(0.037)*	*(0.008)*
6-months	0.257	0.039	0.275	0.194	0.130	0.223
	(0.002)	*(0.386)*	*(0.008)*	*(0.014)*	*(0.011)*	*(0.003)*
9-months	0.171	0.106	0.246	0.192	0.128	0.215
	(0.006)	*(0.064)*	*(0.009)*	*(0.023)*	*(0.030)*	*(0.002)*
1-year	n.a.	0.062	0.206	0.156	0.117	0.212
	n.a.	*(0.198)*	*(0.046)*	*(0.072)*	*(0.019)*	*(0.003)*
2-years	0.232	0.076	0.191	0.030	0.064	0.066
	(0.000)	*(0.122)*	*(0.157)*	*(0.305)*	*(0.063)*	*(0.283)*
5-years	0.154	0.002	0.088	0.045	0.066	0.039
	(0.016)	*(0.972)*	*(0.306)*	*(0.161)*	*(0.002)*	*(0.504)*
10-years	0.081	-0.039	0.035	0.047	0.015	-0.019
	(0.153)	*(0.502)*	*(0.617)*	*(0.080)*	*(0.623)*	*(0.622)*
20-years	0.034	-0.052	0.009	0.042	-0.010	-0.046
	(0.469)	*(0.221)*	*(0.845)*	*(0.038)*	*(0.835)*	*(0.255)*
Nobs. 2/	2348	973	1637	975	2085	968
Noprcs. 3/	32	17	22	15	18	12

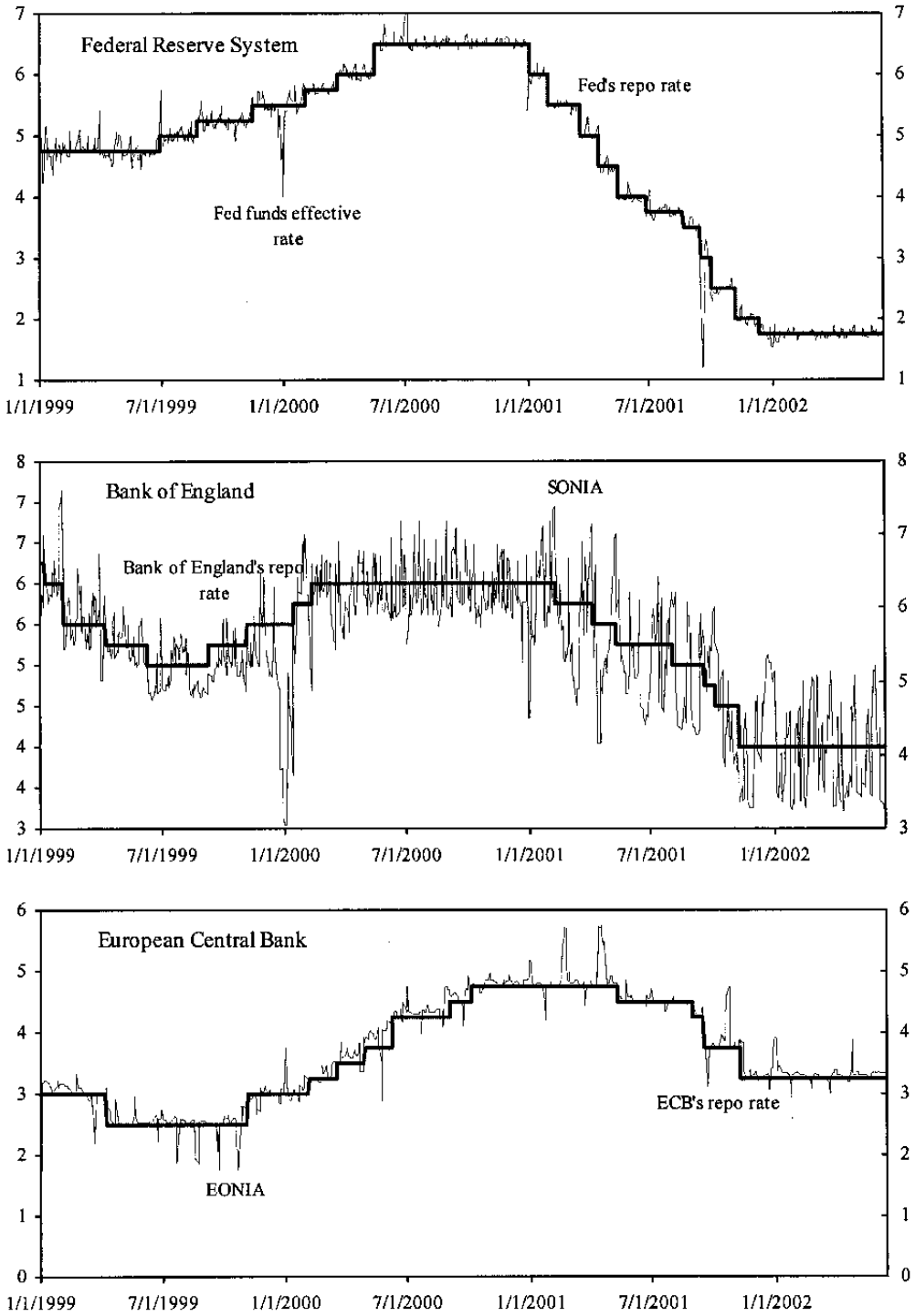
Source: staff estimates.

1/ Numbers in parentheses are p-values, calculated using Newey-West adjusted standard errors.

2/ Number of observations.

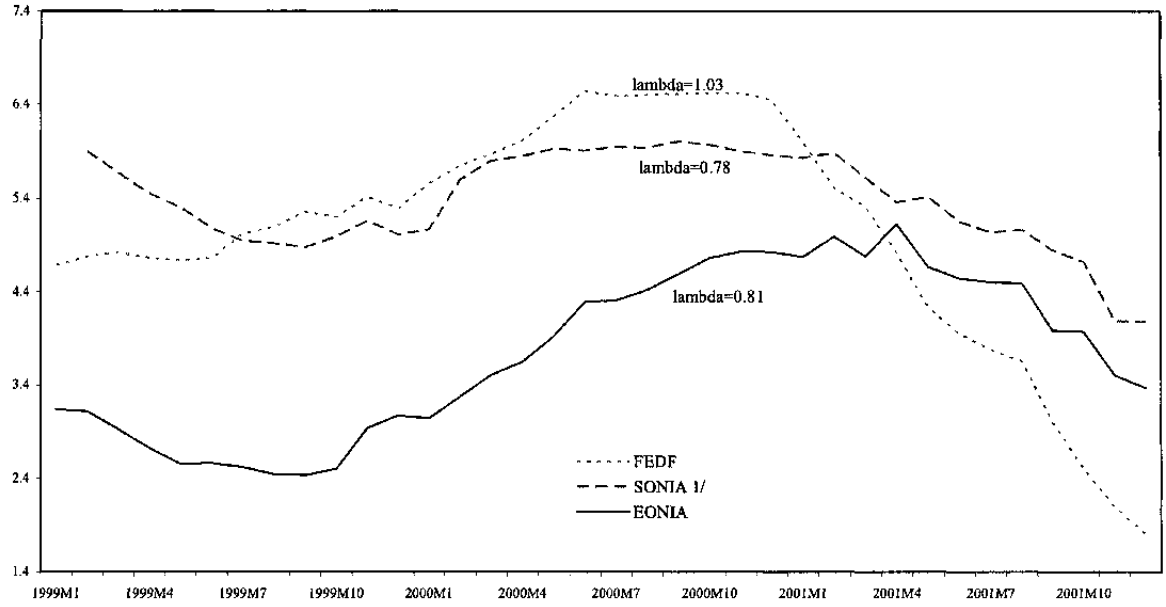
3/ Number of policy rate changes.

Figure 1. Policy Determined and Money Market Interest Rates
(In percent)



Source: Bloomberg.

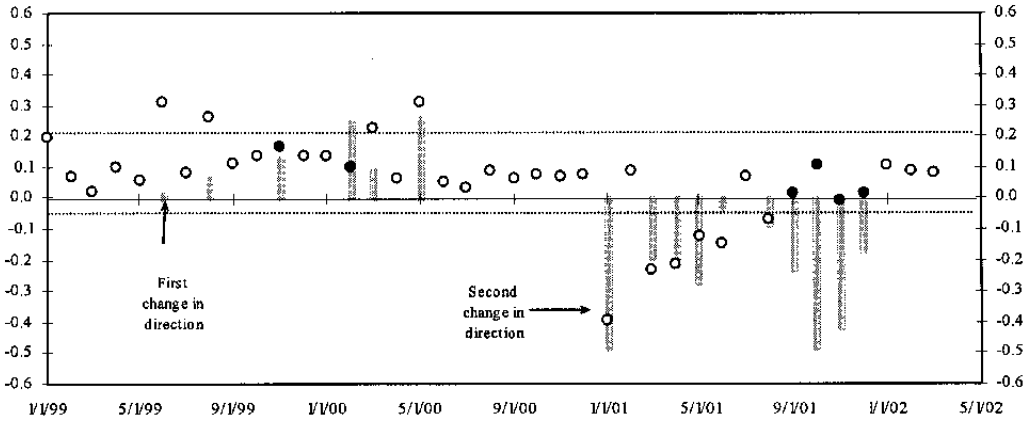
Figure 2. Behavior of Euro Area, U.S., and U.K. Overnight Interest Rates with Estimated Smoothing Coefficients



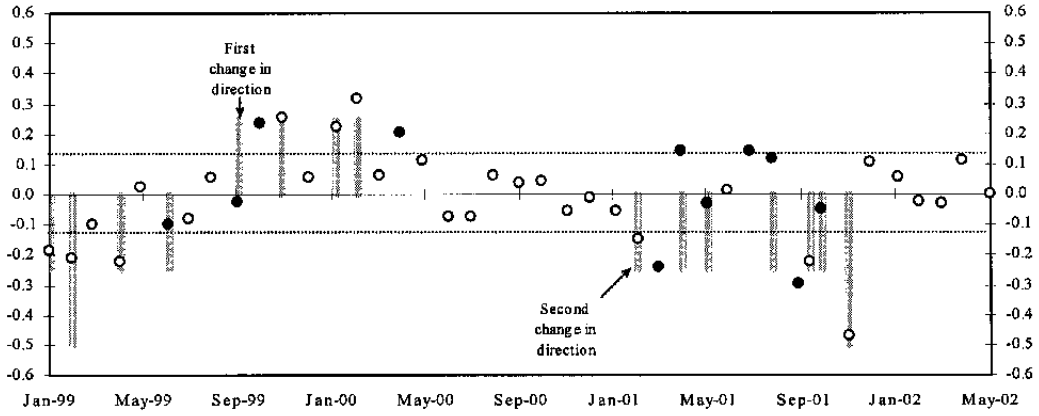
Source: Staff estimates.
1\ Due to high volatility the Sterling Overnight Index Average (SONIA) is a 2 month average.

Figure 3. Financial Market Predictions of Central Bank Policy Decisions

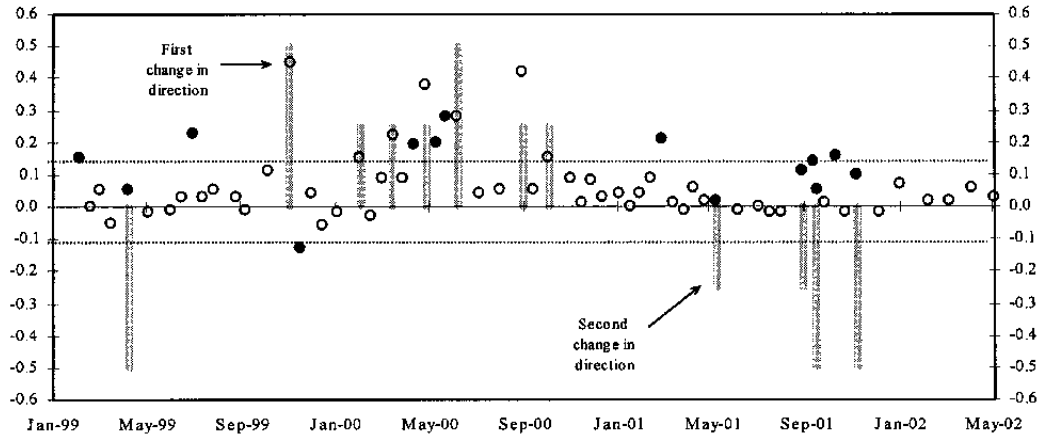
Prediction of United States Federal Funds Target Rate Changes Using Fed Funds Futures Rates 1/ 2/



Prediction of Bank of England Official Repo Rate Changes Using Fitted Forward Curves 2/ 3/ 4/



Prediction of ECB Official Policy Rate Changes Using EONIA Market Rates 2/ 3/ 4/



Source: staff estimates.

1/ Bars represent change in average Fed funds rate (one month ahead) over current target. Circles represent the bias adjusted futures spread. Dotted lines represent range of the historical difference between average effective Fed funds rate and average Fed funds target.

2/ Dark (clear) circles represent incorrect (correct) market predictions.

3/ Bars represent changes in the official rate.

4/ Dotted lines are drawn at +/- 0.125 basis points, reflecting the 50 percent probability of at least a 25 basis point change.

IV. Euro Area Trade Flows and the Exchange Rate: How Much Disconnect?[1]

A. Introduction

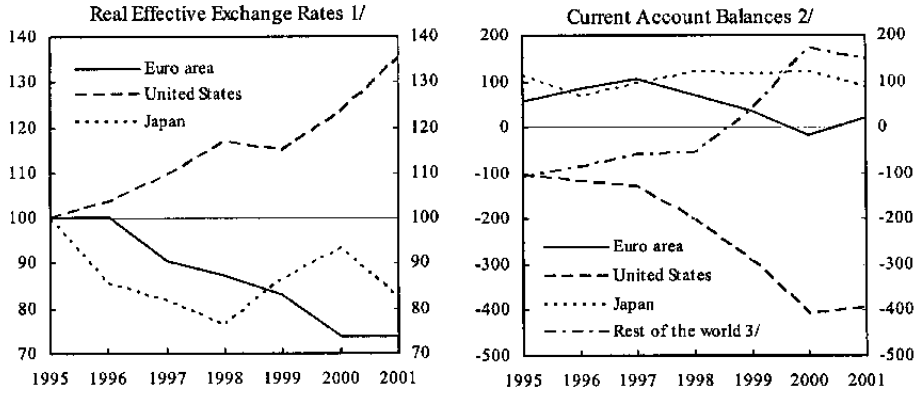
1. Three stylized facts form the backdrop to this chapter:

- The euro area's real effective exchange rate—as measured by the Fund's exchange rate index based on normalized unit labor costs in manufacturing—fell sharply during 1996-2001, the inverse mirror image of the U.S. dollar's appreciation during the same period (Figure 1, left panel).

- The area's current account balance varied little during the same period, particularly when contrasted with the unprecedented increase in the U.S. external deficit (Figure 1, right panel).

- As an accounting implication of the second stylized fact, at the global level the ballooning U.S. external deficit had its counterpart in improved current account positions outside the euro area, with offsetting improvements in external positions mainly occurring in the smaller advanced economies and the developing countries (Figure 1, right panel).[2]

Figure 1. Exchange Rates and Current Account Balances, 1995-2001



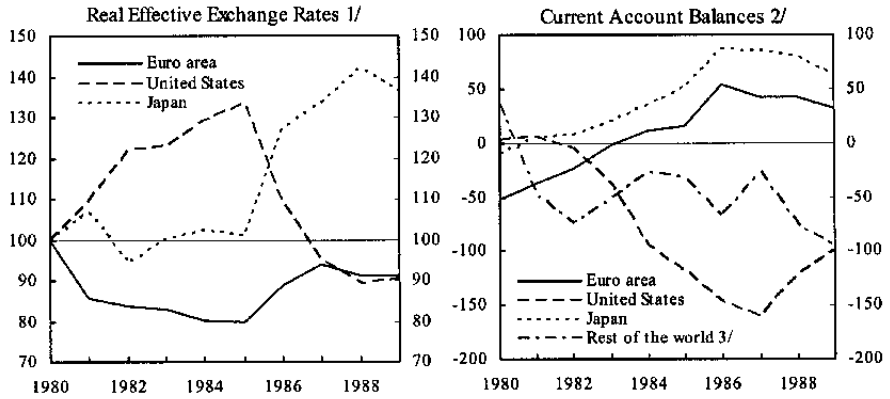
Source: WEO, IMF.
1/ Based on normalized unit labor costs in manufacturing, 1995=100.
2/ In billions of U.S. dollars; euro area balance is sum of individual countries.
3/ Not including global current account discrepancy.

[1] Prepared by Albert Jaeger (Ajaeger@imf.org).

[2] This global pattern of current account balances does not rule out that the euro area may have operated as a "financial turntable" for financing the U.S. current account deficit, with increases in net capital flows from the euro area to the United States financed by increases in net capital flows from other regions to the euro area.

2. *Prima facie*, the three stylized facts appear to fly in the face of conventional empirical wisdom on the link between exchange rates and trade flows. In this view, a depreciation should, all other things being held equal, be accompanied by an improvement in the current account position, albeit perhaps with considerable lags. And a widening external U.S. deficit accompanied by an appreciation of the U.S. dollar against other major currencies should at least in part be mirrored by rising external surpluses in the euro area and Japan. Confidence in this vintage of conventional wisdom on the link between current accounts and exchange rates received a major boost from the global adjustment experience of the 1980s when the U.S. dollar rose and fell sharply against the (at that time implicit) euro exchange rate while the changes in the area's current account position conformed quite closely to the predictions of conventional thinking (Figure 2).[3]

Figure 2. Exchange Rates and Current Account Balances, 1980-1989



Source: WEO, IMF.
1/ Based on normalized unit labor costs in manufacturing, 1980=100.
2/ In billions of U.S. dollars.
3/ Not including global current account discrepancy.

3. Why then did the euro area's current account balance fail to improve in the face of a plunging euro during the second half of the 1990s? A priori, and abstracting from several measurement problems related to the euro area's trade data that are briefly touched upon below, two alternative views seem plausible:

- Conventional wisdom on the link between exchange rates and the current account is based on partial equilibrium thinking, encapsulated in the "all other things being held equal" clause. And there are many "other things" that could have changed in tandem with the exchange rate, and these other factors could have offset the exchange rate's partial equilibrium impact on the current account.

- Alternatively, conventional wisdom could be defective at its very core in that the presumed "connect" between exchange rates and trade volumes for a large open

[3] See the papers in Bergsten (1991) for a *post mortem* analysis of the 1980s experience.

economy is weaker than postulated. More recently, this alternative view has gained traction, partly as a consequence of empirical research that has found little pass-through of exchange rates to consumer prices, particularly for the largest industrial countries;[4] partly as a consequence of theoretical research that has begun to develop coherent models of full "disconnect" between exchange rate swings and the real economy, models that suggest that exchange rates among the large common currency areas may be highly volatile precisely because they have little effect on the real economy.[5]

4. This chapter takes a crude first pass at interpreting the link between the euro exchange rate and (non-oil) trade volumes and prices during 1997-2001. The chapter draws four conclusions:

- Subject to several caveats regarding the quality of euro-area trade statistics and the liberal use of the "all other things are equal" clause, there appears to be strong evidence for disconnect between euro-area exchange rate changes and trade developments during 1997-2001. The disconnect is found, however, to be more pronounced for import volumes and prices, and most strikingly so for capital goods imports. At the same time, however, versions of the disconnect hypothesis based on local currency pricing (i.e. the assumption that import prices are preset in the importer's rather than the exporter's currency) are clearly incompatible with the recent behavior of euro-area trade data, both on the import and export side.

- The chapter's empirical findings suggest caution in using standard econometric model simulations for gauging the macroeconomic effects of a reversal of the euro's depreciation. These models are usually calibrated to produce a close link between exchange rates and trade volumes for the euro area as a whole, reflecting the assumption of close-to-one pass-through of exchange rate changes to import prices at the individual member country level. Following the formation of EMU, however, the exchange rate-trade link for the area as a whole may no longer match up well the econometric relationships implicit in the simple aggregation of individual member countries' trade equations (which are based on the pre-EMU environment).

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[4] See Engel (1999).

[5] See Devereux and Engel (2002). Obstfeld (2002) sketches the intellectual history of the various incarnations of the disconnect view, including "elasticitiy pessimism" at the time of the set up of the Bretton Woods system in the 1940s, "real wage rigidity" during the early 1980s, "pricing to market and sunk cost" during the late-1980s, and "local currency pricing" more recently; his paper also provides an overview of the present debate on the international pricing of goods.

- The chapter's empirical findings also suggest that assessments of whether the area's prevailing real exchange rate is consistent with medium-term fundamentals based on the macroeconomic balance approach should be viewed with caution. The macroeconomic balance approach compares the "underlying current account balance" (i.e. the current account adjusted for output gaps and lagged exchange rate effects) at the present level of the real exchange rate with an estimated saving-investment balance norm. The deviation of the underlying current account from the saving-investment norm is then "translated" into a deviation of the prevailing exchange rate from its medium-run equilibrium level—this step assumes that there is conventional connect between exchange rates and trade flows. Thus, in a situation where the connect between exchange rates and trade flows is in fact weaker, the macroeconomic balance approach might incorrectly signal that because the underlying current account is close to the investment-saving norm the prevailing exchange rate must also be close to its medium-run equilibrium level.

- The implications of the findings for interpreting the apparent global asymmetry in current account adjustments highlighted in Figure 1 are less clear.[6] If exchange rate disconnect is more pervasive for exports to the major common currency areas than for exports to smaller open economies, it is plausible that a deterioration of the U.S. current account could be mostly mirrored by current account improvements outside the major common currency areas. More work on this issue using a multi-country model of trade flows, however, would be needed to draw firmer conclusions.

B. Why Has the Euro Been So Weak?

5. The euro's depreciation since 1996 has defied a coherent and widely accepted explanation.[7] While the euro's nominal bilateral exchange rate fell during 1996-2001 against the currencies of its three main trading partners (United States, United Kingdom, and Japan), the decline was particularly pronounced with respect to the U.S. dollar (Figure 3, left panel). As regards the fundamental sources of the euro's weakness, there is little evidence that the history of the 1980s repeated itself, with shifts in the stances of monetary or fiscal policies providing the key impulses for the U.S. dollar's rise and the euro's decline. Moreover, neither interest differentials nor current account developments appear to be of much help in understanding the observed exchange rate patterns.[8] Most "stories" of the driving forces

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[6] See Chapter II in the September 2002 *World Economic Outlook*, pp. 65-81, for a discussion of the evolution of global current account imbalances and associated policy issues.

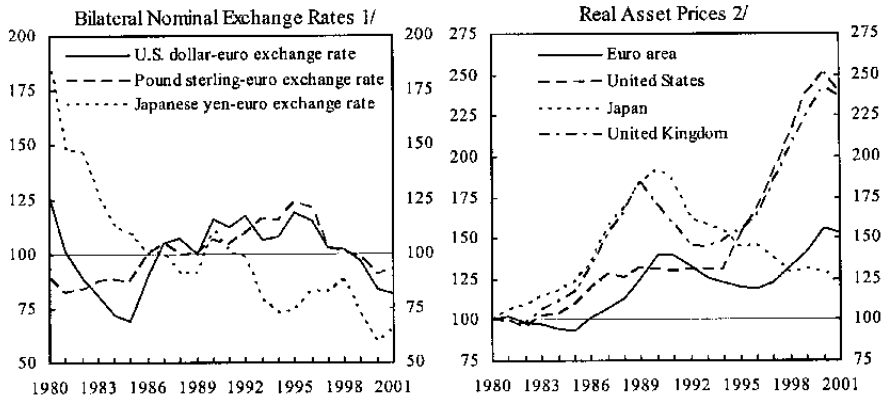
[7] References to the euro's exchange rate before 1999 always pertain to "synthetic euro rates."

[8] See Chapter II in the May 2001 *World Economic Outlook*, pp. 66-75, for an analysis linking the euro's slide vis-à-vis the U.S. dollar to capital flow components. See also last year's *Selected Issues Paper* (SM/01/297), which highlights the roles of the global equity price boom and international diversification pressures on the euro. A cursory attempt to compile a

(continued)

behind the euro's decline have as a common theme, however, that the unprecedented runup in real asset prices (including equities, and residential and commercial real estate) in the United States relative to the euro area during the second half of the 1990s (Figure 3, right panel) should have played some role, although the fundamental reasons for these relative asset price developments remain controversial.

Figure 3. Exchange Rates and Asset Prices, 1980-2001



Sources: Bank for International Settlements (BIS); WEO, IMF; own calculations.
1/ Index, the 1980-2001 average is equal to 100.
2/ Assets include equities, residential real estate, and commercial real estate (inflation-weighted index 1980=100); euro-area data are based on BIS data for Germany, France, Italy, Spain, the Netherlands, Belgium, and Finland.

6. Unfortunately, understanding the underlying sources of exchange rate movements is important for tracing their impact on the current account. From a general equilibrium perspective, the effect of the exchange rate on trade flows can be very sensitive to the ultimate source driving the changes in the exchange rate. For example, econometric model simulations of exchange rate shocks in Bryant et.al. (1988) suggest that an effective depreciation of the U.S. dollar by about 10 percent over the five-year period 1985-89 would have improved the U.S. current account after the five years by 60 billion U.S. dollars if the depreciation was driven by a U.S. fiscal contraction, by only 8 billion dollars if it was caused by a portfolio shift against the U.S. dollar, and by nil if the depreciation reflected a U.S. monetary expansion.[9] Thus, the lack of a coherent account of the factors that caused the euro's depreciation during 1997-2001 is a serious obstacle to understanding its impact on trade flows.

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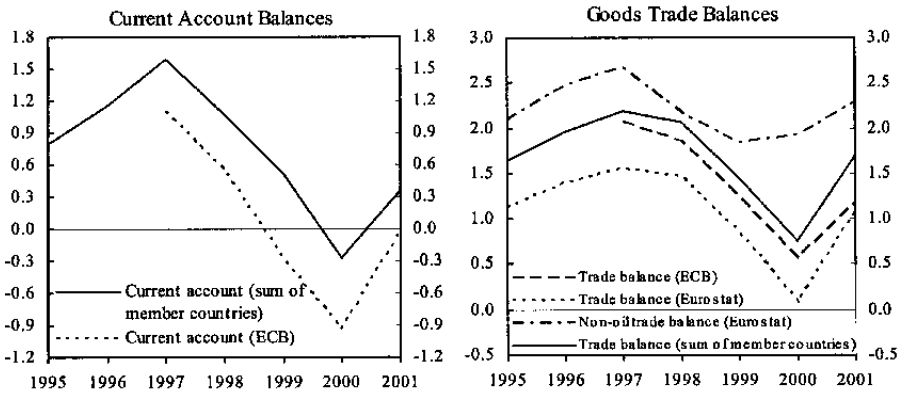
list of explanations of "Why is the Euro so Weak?" suggested that around 25 different explanations have been put forward to account for the euro's persistent weakness.

[9] Own estimates based on the eleven model simulations in table C (fiscal contraction), table F (portfolio shift), and table E (monetary expansion) in Bryant et.al. (1988).

C. Euro-Area Trade Data: Measurement Issues

7. The poor state of the euro area's external account statistics adds another layer of uncertainty to this chapter's analysis. First, the area's official data for the current account balance in Figure 1 were obtained by summing individual member countries' current account balances. Because of biases in the measurement of intra-area trade flows, this sum-of-countries measure of the current balance overstates the area's current account surplus by about ½ percent of GDP. In part this overstatement reflects underreporting of intra-area imports by smaller companies following the introduction of higher reporting thresholds in 1992 (intra-area exports are more likely to be reported because they tend to originate from larger companies that are not exempt from the reporting requirement). The official estimate of the area's current account balance published by the ECB suggests that the area's current account balance in 2001 was zero while the sum-of-countries measure yields a surplus of 0.4 percent of GDP (Figure 4, left panel).

Figure 4. Euro Area Current Account and Goods Trade Balance Data, 1995-2001 1/



Sources: European Central Bank (ECB); WEO, IMF.
1/ In percent of GDP.

8. The data situation is even more diffuse when it comes to measures of the area's trade balance for goods. Analysts here have the choice among three measures: (i) the sum-of-countries measure; (ii) the official measure published by the ECB as part of its balance of payments statistics, which tries to correct for the already mentioned intra-area biases in trade flow statistics; and (iii) a Eurostat measure based on extra-area flows in goods trade, which in turn is not directly comparable with the ECB measure because of differences in definitions, coverage, and the timing of recording. As can be seen from Figure 4 (right panel), the differences between the current account balances based on sum-of-member measure and the ECB measure (about ½ percent of GDP) reflect similar differences in the underlying trade balance measures.[10]

[10] As an aside, would using the ECB's bias-adjusted measures of the external current account balance (instead of using the sum-of-countries measure as presently the case) reduce the

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9. The empirical analysis in the rest of the chapter will be based on Eurostat's trade statistics, largely because trade in goods is the major driver of the overall current account balance in the euro area, and only the Eurostat data provide detailed extra-area statistics for export and import volumes and prices including for different goods categories. A major disadvantage of the Eurostat data set is, however, that the price data are only provided as unit value indexes rather than true price indexes, entailing well-known measurement problems. Finally, because pass-through of exchange rate changes to oil prices is likely to be almost immediate and full,[11] the focus of the empirical analysis throughout the rest of the chapter will be on non-oil trade flows and the non-oil trade balance as provided by Eurostat's trade statistics (Figure 4, right panel).

D. Gauging Exchange Rate Disconnect

10. The nominal trade balance (TB_t) as a percent of nominal GDP (Y_tP_t) (where Y_t stands for real GDP and P_t for the GDP deflator) is equal to the difference between exports (defined as the product of real exports (X_t) and export prices (PX_t)) and imports (defined as the product of real imports (M_t) and import prices (PM_t)):

$$(1) \qquad TB_t/(Y_tP_t) = (X_t/Y_t)(PX_t/P_t) - (M_t/Y_t)(PM_t/P_t).$$

At this descriptive level, the change in the nominal trade balance (as a percent of GDP) can (approximately) be decomposed into trade balance effects due to changes in export and import volumes ("volume effects") and trade balance effects due to changes in export and import prices ("terms of trade effects"):

$$(2) \qquad \Delta(TB_t/(Y_tP_t)) \approx (\mu_x\Delta x_t - \mu_m\Delta m_t) + (\mu_x\Delta px_t - \mu_m\Delta pm_t),$$

where μ_x and μ_m are the nominal export- and import-GDP ratios, respectively, and small letters for trade variables denote their growth rates; the first term in parentheses on the right hand stands for the "volume effect" while the second term reflects the "terms of trade effect."

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global current account discrepancy? The answer appears to be no. For example, in 2000 the global current account discrepancy amounted to $128 billion, reflecting a "global goods trade surplus" of $16 billion and combined deficits of $144 billion in the non-goods balance items (see IMF (2001), Table 1). Thus, if the euro area would have reported the ECB's bias-adjusted current account deficit of $55 billion for 2000 (instead of the sum-of-countries deficit of $15 billion), this would have boosted the global current account discrepancy by some 40 billion U.S. dollars. This does not, however, point to any inadequacies with regard to the ECB measure.

[11] See Campa and Goldberg (2002) for detailed cross-country estimates of exchange rate pass-through to import prices for oil and coal.

11. The relative contributions of trade volumes and prices to the changes in the euro area's non-oil trade balance (as a percent of GDP) are set out in Table 1. The non-oil trade balance during 1996-2001 declined by ¼ percent of GDP, with a small positive volume effect (½ percent of GDP) overcompensated by a negative terms of trade effect (¾ percent of GDP). As a consequence, the area's non-oil trade balance during 1996-2001 was essentially flat.

Table 1. Euro Area: Decomposition of Changes in Non-Oil Trade Balance, 1996-2001

	1996	1997	1998	1999	2000	2001	Total change 1996-2001
				(In percent of GDP, unless noted otherwise)			
Non-oil trade balance	2.5	2.7	2.2	1.8	1.9	2.3	
Change in non-oil trade balance		0.2	-0.5	-0.3	0.1	0.3	-0.2
Change due to volume effects:		0.4	-1.5	-0.2	1.2	0.5	0.4
Export volumes		1.5	0.5	0.3	1.7	0.0	4.1
Import volumes		-1.1	-2.0	-0.5	-0.6	0.5	-3.6
Change due to terms of trade effects:		-0.3	0.9	-0.1	-1.1	-0.1	-0.7
Export unit values		0.4	0.1	0.3	1.2	0.5	2.5
Import unit values		-0.7	0.7	-0.4	-2.2	-0.6	-3.2
Memorandum items:							
Non-oil goods terms of trade (1996=100)	100.0	97.5	104.5	103.6	95.0	93.5	
Nominal goods exports-GDP ratio	12.1	13.5	13.6	13.6	15.7	15.4	
Nominal goods non-oil imports-GDP ratio	9.6	10.8	11.4	11.7	13.8	13.2	

Sources: Eurostat; own calculations based on equation (2) in text; volume and terms of price may not add up because equation (2) holds approximately.

12. As the next step, consider an analytical decomposition of the change in the trade balance (as a percent of GDP) in terms of responses to the exchange rate (E_t) and in terms of responses to "all other things", where it is convenient to think about "all other things" as being broken down into those factors affecting volumes (AV_t) and those factors impacting on the terms of trade (AT_t):

$$(3) \qquad \Delta(TB_t/(Y_tP_t)) = [AV_t - (\mu_x\beta_x + \mu_m\beta_m)\Delta e_t] + [AT_t - (\mu_x\gamma_x - \mu_m\gamma_m)\Delta e_t].$$

In equation (3), β_x and β_m denote price elasticities of export and import volumes with respect to the exchange rate (reflecting "trade volume sensitivity"), and γ_x and γ_m are the elasticities of export and import prices with respect to the exchange rate (capturing "pass-through to trade prices"). The assumption that the trade variables respond only to current exchange rate changes is made for expositional convenience (the empirical work will allow for up to 4 year lags). The terms in the first bracket can be interpreted as a decomposition of the overall volume effect in equation (2) in the portion explained by the exchange rate and "all other things," while the second bracket provides the analogous decomposition for the overall terms of trade effect in equation (2).

13. As a benchmark for characterizing conventional wisdom on the exchange rate-trade link, the empirical analysis in this chapter will use representative short- and long-run estimates of price elasticities for trade volumes and prices (Table 2). Similar estimates are embedded in the trade volume and price equations of many standard econometric models, and they correspond closely to what Krugman's summing up paper in the Bergsten (1991) volume termed "empirical conventional wisdom." According to this benchmark, exchange rate depreciations are assumed to raise import prices one-to-one, albeit with one-year lag, while export prices are assumed to increase only modestly. Thus, one clear implication of the conventional wisdom view is that the terms of trade should deteriorate about one-to-one in response to an exchange rate depreciation. While export and import volumes are assumed to react much more slowly to exchange rate changes than prices, the representative long-run price elasticities in Table 2 clearly fulfill the Marshall-Lerner condition (that the sum of the two elasticities exceeds one).

Table 2. Representative Trade Elasticities Based on Conventional View of Linkage Between Trade Flows and Exchange Rate

	Export volumes	Import volumes	Export prices	Import prices
Year 1	0.14	0.18	0.10	0.50
Year 2	0.36	0.46	0.10	0.50
Year 3	0.14	0.18	0.00	0.00
Year 4	0.04	0.05	0.00	0.00
Year 5	0.04	0.05	0.00	0.00
Long-run elasticities	0.71	0.92	0.20	1.00

Sources: Own calculations; trade elasticities based on Bayoumi and Faruqee (1998) and the results of the six econometric models reported in Bryant, Holtham, and Hooper (1988).

14. An illustrative path for the trade balance in response to a 10 percent depreciation of the exchange rate based on the elasticities in Table 2 is shown in Table 3. Following a first-year deterioration in the current account owing to a small J-curve effect (import price pass-through is assumed to be relatively fast compared with trade volume responses in the first year), the current account improves by about 1¼ percentage points of GDP, with most of the trade balance adjustment completed after three years.

Table 3. Response (in percent of GDP) of Euro Area Non-Oil Trade Balance to a 10 percent Real Depreciation under Conventional View of Trade-Exchange Rate Link

		Contributions by:				Memo items	
	Trade Balance	Export volumes	Import volumes	Export prices	Import prices	Total volume effect	Terms-of-trade effect
Year 1	-0.04	0.20	0.22	0.14	-0.61	0.43	-0.47
Year 2	0.57	0.72	0.79	0.29	-1.22	1.50	-0.93
Year 3	1.00	0.92	1.01	0.29	-1.22	1.93	-0.93
Year 4	1.11	0.97	1.07	0.29	-1.22	2.04	-0.93
Year 5	1.21	1.02	1.12	0.29	-1.22	2.14	-0.93

Source: Own calculations based on the trade elasticities in Table 1.

15. The setup provided by equation (3) suggests at least two interpretations of "exchange rate disconnect:"

- First, exchange rate disconnect could mean that exchange rate changes do not affect the nominal trade balance (always holding constant the "all other things" terms, which may themselves depend on the exchange rate) because (positive) volume effects are small and could be offset by (negative) terms of trade effects. This view of exchange rate disconnect appears to underlie classic elasticity pessimism (see Obstfeld (2002, pp. 2-3).

- Second, (positive) volume effects are small because of "local currency pricing," i.e. the assumption that import prices are preset in the importer's rather than in the exporter's currency. Under an extreme version of local currency pricing, export prices in domestic currencies could be viewed as adjusting proportionally to the change in the exchange rate, with a depreciation increasing export prices in domestic currencies and pass-through to import prices zero. Trade volumes would not react to exchange rate changes, but the terms of trade would improve, leading to an overall improvement in the trade balance. In fact, looking only at movements in the trade balance, the conventional and local currency pricing views of the link between exchange rates and trade flows could be observationally equivalent, although the implications of the views for trade volume responses are radically different.

16. The remainder of the chapter uses equation (3) to shed some light on the degree of connect between exchange rates and trade volumes and prices during the period 1997-2001. At the outset, however, it is important to point out that the presence of the unobserved "all other things" terms in equation (3) suggest that this type of partial equilibrium analysis can only support tentative conclusions.

17. As the most simple exercise, assume that AV_t and AT_t are kept constant and that trade variables only respond to exchange rate changes. Then, a simulation can be used to calculate a path for the various trade variables during 1997-2001 based on the actual real exchange rate path using the representative trade elasticities in Table 2. Table 4 compares the simulated changes in the non-oil trade balance and in underlying trade volumes and prices with the results in Table 1. The results of this simulation can be compared with the results in Table 1. In response to the cumulative depreciation in the real effective exchange rate of the euro by almost 30 percent, the non-oil trade surplus increases to about 4¾ percent of GDP by 2001, rising some 2½ percent of GDP above its actual value in 2001.[12] Thus, this benchmark simulation suggests that the path for the area's non-oil trade surplus would have been significantly above actual outcomes if conventional wisdom on the link between trade flows

[12] Assuming that the real exchange rate remains constant from 2002 onward, owing to the long lags between movements in the exchange rate and trade volumes the simulated trade surplus would rise to 5¾ of GDP by 2004.

and the exchange rate had applied and if other things had been equal. Turning to the underlying reasons for the apparent disconnect in the actual data relative to the benchmark case, the most striking "discrepancy" occurs with regard to volume effects, which are found to be much lower in the actual data. As regards the terms of trade effects on the trade balance, the discrepancy between actual and simulated data is less significant than for volumes, but the overall terms of trade effect in actual data is clearly smaller than implied by conventional pass-through assumptions.

Table 4. Simulated Changes in Non-Oil Trade Balance Conditional on Representative Trade Elasticities and Actual Real Exchange Rate Path During 1997-2001

	Actual change 1996-2001	Simulated change 1996-2001	Deviation from actual
Change in non-oil trade balance	-0.2	2.3	2.5
Change due to volume effects:	0.4	4.3	3.9
Export volumes	4.1	2.2	-1.9
Import volumes	-3.6	2.1	5.7
Change due to terms of trade effects:	-0.7	-2.0	-1.3
Export unit values	2.5	0.7	-1.7
Import unit values	-3.2	-2.7	0.4

Sources: Eurostat; own calculations based on equation (2) in text; volume and terms of price may not add up because equation (2) holds approximately.

18. The previous benchmark simulation can only be illustrative because "other things" have clearly not been equal. Short of applying a full-fledged general equilibrium approach—an approach that looks forbidding in view of the mentioned uncertainties surrounding the driving forces behind the euro's decline—a less ambitious approach consists in allowing for two other key factors (besides changes in the exchange rate) that drive trade flows: (i) the effects of domestic and foreign absorption growth on trade volumes; and (ii) the effects of domestic and foreign cost developments on domestic trade prices.[13] The elasticities of export and import trade volumes with respect to foreign and domestic real absorption growth are assumed to be 1.5 and 2.0, respectively, the difference between the two parameters being motivated by the stylized fact that trading partners' absorption grows somewhat faster than euro-area absorption.[14] The elasticities of export and import prices with respect to domestic

[13] This approach is roughly equivalent to the "benchmark comparators" approach outlined in Appendix II of Isard et.al. (2001).

[14] The relative size of the trade income elasticities has been calibrated to align them with Krugman's (1989) "45-degree rule," namely that in the long run the ratio of domestic to foreign absorption growth should be roughly equal to the ratio of the income elasticity for exports to the income elasticity for imports. Advanced trading partners' absorption growth

(continued)

and foreign cost developments are set at 1.0, and the domestic and foreign inflation rates of the GDP deflators are used to proxy domestic and trading partners' cost developments.

19. A simulation of the path for the euro-area non-oil trade balance during 1997-2001 based on these more general assumptions largely confirms the results of the benchmark simulation (Tables 5). In this more refined simulation, the actual non-oil trade balance in 2001 falls short of the balance's simulated value in 2001 by about 2 percent of GDP. A detailed breakdown in terms of underlying trade volume and price responses of why the simulated non-oil trade balance deviates from outcome data for 1997-2001 suggests:

- The largest discrepancies between actual and simulated data occur on the import side. Actual non-oil import volumes grew on average much faster than in the simulation, while pass-through of the depreciation to import prices was far from complete.

- Actual export volume and price developments are, by contrast, closer to the simulated averages. There is only weak evidence for local currency pricing by euro-area exporters as actual export price inflation exceeds simulated average export inflation only by a small margin.

Table 5. Simulated Changes in Non-Oil Trade Balance Conditional on Representative Trade Elasticities, Actual Real Exchange Rate Path, and Domestic and Foreign Absorption and Cost Developments During 1997-2001

	Actual change 1996-2001	Simulated change 1996-2001	Deviation from actual
Change in non-oil trade balance	-0.2	1.9	2.1
Change due to volume effects:	0.4	5.1	4.7
Export volumes	4.1	5.7	1.7
Import volumes	-3.6	-0.6	3.0
Change due to terms of trade effects:	-0.7	-3.2	-2.5
Export unit values	2.5	1.8	-0.7
Import unit values	-3.2	-4.9	-1.8

Sources: Eurostat; own calculations based on equation (2) in text; volume and terms of price may not add up because equation (2) holds approximately.

20. As a final exercise, Table 6 provides additional simulations using a breakdown of goods trade in intermediate, capital, and consumption goods. While the results in Table 6 confirm the previously observed asymmetry for all goods categories, i.e. import volumes and prices appear to be more disconnected from exchange rate changes than export volumes and

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during 1997-2001 was about 3 percent, while the euro area's absorption grew by 2¼ percent during the same period.

prices, the results additionally suggest that "disconnect" is clearly strongest for capital goods imports—perhaps in part reflecting a rising share of relatively price-inelastic high tech goods—and probably least pronounced for intermediate goods.[15]

Table 6. Euro Area: Simulation of Exchange Rate Impact on Goods Trade Categories, 1997-2001

	Intermediate goods 1/	Capital goods	Consumption goods
	(Average growth rate during 1997-2001, in percent)		
Export volumes			
Simulated	8.2	8.2	8.2
Actual	4.9	6.4	5.9
Simulated minus actual	3.3	1.8	2.3
Export unit values			
Simulated	2.5	2.5	2.5
Actual	3.5	3.5	3.4
Simulated minus actual	-1.0	-1.0	-0.9
Import volumes			
Simulated	0.4	0.4	0.4
Actual	4.9	10.7	4.5
Simulated minus actual	-4.5	-10.2	-4.0
Import unit values			
Simulated	7.6	7.6	7.6
Actual	5.4	4.1	4.3
Simulated minus actual	2.2	3.5	3.3

Sources: Eurostat; and own calculations.

1/ Intermediate goods imports exclude oil.

[15] This finding echoes the finding in Krugman's (1987) classic article on pricing-to-market, which reported an unusual degree of disconnect between exchange rate changes and export prices in the case of German exports of machinery and equipment to the U.S.

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