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EURO AREA POLICIES

Selected Issues

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Approved by the European I Department

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I. Is Inflation Persistence Higher in the Euro Area than in the United States?[1]

A. Introduction

1. Inflation rates that remained stubbornly above target long after the burst of the global high-tech bubble prevented the ECB from slashing interest rates quite as aggressively as the U.S. Federal Reserve in response to the deepening economic gloom. While partly explained by a softer downturn in activity, this recent experience has brought to the fore an old question: is inflation in Europe more "persistent" than in the United States in the sense of being less responsive to demand or monetary shocks? If so, such persistence might account for the sometimes perceived tendency of European central bankers to be less 'activist' and less responsive to output developments than their cross-Atlantic counterparts.

2. This chapter provides fresh evidence on the degree of inflation persistence in the euro area relative to the U.S., as well as the sources of that persistence. In particular, the investigation uses real-time inflation forecasts to measure near-term inflation expectations, and tries to discriminate between structural sources of persistence and persistence that arises from the way expectations are formed, including imperfect knowledge of monetary policy objectives. The paper also uses survey evidence of long-run inflation expectations as a measure of agents' perceived long-run inflation anchor, and evaluates the extent to which gradual movements in the perceived long-run inflation objectives of the monetary authorities contributed to observed persistence.

3. Perhaps surprisingly, the chapter concludes that inflation persistence is only moderately higher in the euro area than in the United States, if at all, and there is little firm evidence that structural sources of persistence play a bigger role in the euro area. This is in line with other results from the recent Phillips-curve literature, although somewhat at odds with evidence, e.g. on the response of prices and output to monetary shocks. Consequently, the results in this paper need to be followed up by a better understanding of how the consequences of structural rigidities may already be internalized in the expectations variable. Investigations at the individual country level, rather than the euro-area aggregates used here, could also help shed light on the sources of persistence which are likely to differ among countries.

B. Definition and Sources of Inflation Persistence

4. Persistence in inflation denotes the tendency of inflation to be a slow-moving, inertial variable with autocorrelations fairly close to one. Different sources of inflation persistence can be illustrated in the context of the following Phillips-curve specification which is adapted from Gerlach and Svensson (2002) (Phillips curve specifications based on more rigorous micro foundations are considered below):

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[1] Prepared by Mads Kieler.

$$(1) \qquad \pi_t = \alpha\pi^* + (1-\alpha)\pi_{t-1} + \beta gap_t + \varepsilon_t$$

In this equation, inflation depends on the central bank's inflation target, π^* (owing to forward-looking expectations) and last period's inflation π_{t-1} (owing to backward-looking expectations, or institutional factors that make inflation dependent on its own history); the output gap(gap_t); and an error term (ε_t) which captures import price and other shocks. In this scheme of things, inflation is more inertial, the smaller is α (i.e., the less firmly inflation expectations are anchored on the central bank's target and the more current inflation is conditioned by past inflation); the more persistent are movements in the output gap; and the smaller is the coefficient β, i.e. the less inflation responds to the output gap.[2]

5. This framework for thinking about persistence illustrates that a given degree of inertia may be caused by quite different underlying factors. For instance, observed inflation persistence in the U.S. could be importantly related to a shifting anchor for inflation, especially during the 1970s and early 1980s, while historical inflation persistence in price stability-oriented Germany might be more closely linked to a weak response of wages and inflation to the output gap. European countries with less firm anchoring of inflation expectations than Germany but equally significant structural rigidities might have experienced high persistence on both counts.

6. A priori, the monetary anchor for inflation expectations (π^*) and/or the degree to which expectations have been linked to this anchor (α) seem likely to have varied significantly over recent decades. An important aim of this paper is to take shifts in the long-run anchor into account in the empirical specifications.

C. A Quick Refresher Course in Phillips Curve Specifications

The traditional Phillips-curve

7. The traditional expectations-augmented Phillips-curve in the spirit of Edmund Phelps and Milton Friedman has the form:

$$(2) \qquad \pi_t = E_{t-1}(\pi_t) + \beta gap_t + \varepsilon_t$$

In empirical work it has often been implemented assuming adaptive or backward-looking expectations, thus giving rise to what is generally termed the 'accelerationist' Phillips curve:

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[2] Batini and Nelson (2001) define three types of persistence: (1) positive serial correlation in inflation; (2) lags between *systematic* monetary policy actions and their (peak) effect on inflation; and (3) lags between *non-systematic* policy actions and inflation. The two last measures depend also on the transmission of monetary policy actions to *output* (and other variables), making those concepts broader than the considerations adopted here.

$$(3) \qquad \pi_t = \pi_{t-1} + \beta gap_t + \varepsilon_t$$

Although this empirically-motivated Phillips curve is often said to match the data quite well, it is unable to track changes in expectations formation across different regimes. For instance, it fails to explain why persistence appears to have declined in the more stable inflation regime of the 1990s (see below). It also fails to explain the lack of persistence in U.S. inflation during the Gold standard (see Alogoskoufis and Smith (1991)). These failures reflect its lack of micro foundations and is but one example of how models that do not incorporate forward-looking or rational agents can go astray when regimes change, as famously demonstrated by Lucas (1975).

The New Keynesian Phillips curve

8. In line with theoretical advances, the traditional Phillips curve has given way—at least in much theoretical work—to the New Keynesian Phillips curve (NKPC), which can be derived from micro foundations in models of price adjustment with monopolistic competition and costs of adjusting prices. When marginal costs are assumed to be proportional to the output gap the New Keynesian Phillips curve has the following form (for simplicity, the discount factor on next-period inflation has been omitted; derivation usually follows Calvo 1983):

$$(4) \qquad \pi_t = E_t(\pi_{t+1}) + \beta gap_t + \varepsilon_t$$

The equation deviates from the traditional Phillips curve in that it substitutes forward-looking inflation $E_t(\pi_{t+1})$ for backward-looking inflation π_{t-1}. The coefficient on the output gap depends on the frequency of price adjustment, reflecting *nominal* rigidity, and the responsiveness of firms' desired relative prices to economic activity, reflecting *real* rigidities.

9. Although innocent-looking, the substitution of forward-looking inflation for lagged inflation is anything but a minor alteration: it changes the dynamics of the output-inflation relationship fundamentally. Under the new Keynesian Phillips curve, inflation *lacks (inherent or structural) persistence.* Prices are rigid due to menu costs, but their rate of change would not depend on their lagged rate of change.

10. The New Keynesian Phillips curve has been criticized by some for failing to match the observed inflation persistence in the data (e.g., Fuhrer and Moore (1995), and Fuhrer (1997)). By the same token, the model is inconsistent with the generally held view that monetary policy shocks initially affect output and have a delayed and gradual effect on inflation, at least if that proposition is taken to hold everywhere and always. Mankiw puts it most strikingly: "*Although the new Keynesian Phillips curve has many virtues, it also has one striking vice: it is completely at odds with the facts...This harsh conclusion shows up several places in the recent literature, but judging from the continued popularity of this*

model...it's fair to say that its fundamental inconsistency with the facts is not widely appreciated."[3]

The hybrid Phillips curve

11. This state of affairs has led numerous researchers, in the tradition of Chadha, Masson, and Meredith (1992), to use a 'hybrid' formulation which includes both forward-looking and lagged inflation:

$$(5) \qquad \pi_t = \alpha E_t(\pi_{t+1}) + (1-\alpha)\pi_{t-1} + \beta gap_t + \varepsilon_t$$

The lag dynamics may be related to either expectation formation or *structural* features of the economy. Structural persistence can be derived from models of *staggered wage or price setting* in the spirit of Taylor (1980)[4] or *frictions in price adjustment* in the tradition of Rotemberg (1982), possibly around a path determined by trend inflation (see e.g., Kozicki and Tinsley (2002)). Examples of frictions in price adjustment include the deterrent effect of uncertainty about whether competitors will also raise their prices, the unwillingness of firms to upset customers, and lags between cost changes and price adjustments—these three factors have been identified as important explanations of price stickiness in surveys of corporate officers in the United States, see Blinder, Canetti, Lebow, and Rudd (1998). The existence of *formal wage indexation mechanisms*, formerly widespread and still present in the euro area, creates a further reason for including lagged inflation.

12. Alternatively, the addition of lagged inflation is sometimes justified by assuming that a fraction of price-setters have backward-looking expectations or use rule-of-thumb pricing (i.e., it presupposes deviations from full rationality).

13. Models derived from staggered contracts or costly price adjustment typically impose certain restrictions on the coefficients on backward- and forward-looking inflation, while less formalized approaches leave the relative weights to be determined by the data.

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[3] Others have argued that the observed inflation persistence could be consistent with the NKPC as a result of how monetary policy is conducted (Goodfriend and King, 2001).

[4] The inflation equation derived from Taylor-style contracts will depend explicitly on lagged inflation (and lagged output gaps) if the maximum contract length exceeds two periods. Fuhrer and Moore found, however, that Taylor-based models could not generate enough persistence to match U.S. data and proposed an alternative specification inspired by the relative wage contracting model of Buiter and Jewitt (1981). The Fuhrer-Moore model has been widely criticized for lacking credible micro foundations.

14. Although the hybrid specification might seem to offer a "quick fix" to the problems allegedly besetting the NKPC, it has also been contended that the hybrid equation combines the vices of its two lines of origin: as in the NKPC, inflation may respond immediately to monetary policy shocks (unless *all* agents are backward-looking), but as in the traditional Phillips curve, the hybrid model may fail to explain differences in the degree of persistence across different monetary regimes (Ball, Mankiw, and Reis (2002)).

Shifting monetary policy anchor (inflation objective)

15. A recent strand of the literature takes into account the public's learning about changing monetary policy objectives and/or a shifting monetary anchor over time. Persistence arises in such models from the interaction of inflation expectations with monetary policy formulation, and do not require non-rational behavior.

16. Erceg and Levin (2002) assume that households and firms have limited information about the central bank's objectives and use 'optimal filtering' to disentangle persistent and transitory shifts in the monetary policy rule. They show that inflation persistence can be generated in an optimizing-agent framework where it is *not* an inherent or structural characteristic of the economy. In this framework, the degree of persistence varies with the stability and transparency of the monetary policy regime and the costs of disinflation are strongly diminished if agents quickly realize that a credible shift in the inflation target has taken place.

17. In a similar vein, Kozicki and Tinsley (2002) consider shifts in the long-run anchor of inflation expectations (the perceived inflation target) as a source of lag dynamics. Essentially, they show that standard expressions derived from staggered contracts or frictions in price setting can be formulated (approximately) in terms of the deviation of inflation from its perceived long-run anchor. They find that shifts in the long-run inflation anchor have contributed importantly to observed persistence in U.S. (and Canadian) inflation, but such shifts do not appear to explain all of the historical persistence in inflation, suggesting that less than full policy credibility and inherent inflation stickiness have also been important factors.

Sticky-information

18. Another recently proposed approach is the sticky-information model of price adjustment put forward by Mankiw and Reis (2001) and empirically implemented for the United States, Canada, and the United Kingdom by Khan and Zhu (2002).

19. The essence of Mankiw and Reis' model is that information about macroeconomic conditions diffuses slowly through the population, either because of costs of information acquisition or costs to reoptimization.[5] Although prices are continuously changing in this

[5] Zbaracki et.al. (2000) studied the costs associated with changing prices at a large manufacturing firm. Only a small percentage of these costs were the physical costs of

(continued)

model, price adjustments are not always based on current information. Consequently, the current price level will depend on the expectation of current prices formed quite far in the past. Although expectations are rational and central bank credibility matters, the dynamic response of inflation in the sticky-information model resembles backward-looking Phillips curves. However, the farther in advance a disinflationary policy is announced and the more credible it is, the smaller is the accompanying output contraction.

20. The sticky information Phillips-curve has the following form:

$$(6) \qquad \pi_t = \tfrac{\lambda\alpha}{1-\lambda} gap_t + \lambda \sum_{j=0}^{\infty} (1-\lambda)^j E_{t-1-j}[\pi_t + \alpha \Delta gap_t]$$

Inflation depends on the output gap and past expectations of current inflation as well as the growth rate of output. Note the timing of expectations: what matters is past expectations of current conditions, not current expectations of future conditions as in the NKPC.

D. Empirical Strategy

21. We now have a fairly wide set of potential causes of inflation persistence, including structural features of the economy; backward-looking expectations; imperfect monetary credibility and gradual learning about shifting monetary policy targets; and costly or imperfect information gathering.

22. To compare the degree and sources of inflation persistence in the euro area (EA) and the United States, a four-pronged strategy is followed:

- *Univariate models:* the overall degree of inflation persistence is measured by the sum of coefficients in a regression where inflation is explained by its own lags. Attention is paid to how the degree of persistence may have changed over time, and what role shifting monetary anchors for inflation may have played in inducing persistence. To this end, estimates of long-run inflation anchors are constructed using long-term inflation forecasts from surveys of professional forecasters, and IMF projections.

- *VAR-models:* simple vector autoregressions in inflation and output are used to judge the impact of shocks to output or prices on inflation, and whether these might be different on the two sides of the Atlantic.

- *Phillips-curve specifications:* using survey/forecast measures of expectations, the NKPC is estimated and tested against alternatives such as the traditional accelerationist and expectations-augmented Phillips curves and the hybrid model.

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printing and distributing price lists. Far more important were the costs of information-gathering, decision-making, negotiation, and communication.

This reveals whether lagged inflation contributes to explain inflation for structural reasons over and above any impact it may have on (survey) expectations. Moreover, the response of inflation to the output gap is compared between the U.S. and the EA.

- *Expectations formation:* the extent to which survey expectations may have backward-looking elements, as opposed to the extent to which they are aligned on the long-run anchor, is investigated in various settings.

E. Main Features of the Data

23. For the euro area as well as the United States, inflation is measured by the GDP deflator and a measure of consumer prices. For the latter, the CPI for the U.S. and the private consumption deflator for the euro area is used in order to achieve the best possible correspondence with those measures of inflation for which survey expectations or historical inflation projections are available.

24. For the United States, survey expectations of inflation from 1 to 8 quarters and over a 10 year horizon are readily available from the Federal Reserve Bank of Philadelphia's surveys of professional forecasters. The long-run inflation expectations (10 year CPI forecasts) are available since the fourth quarter of 1979.

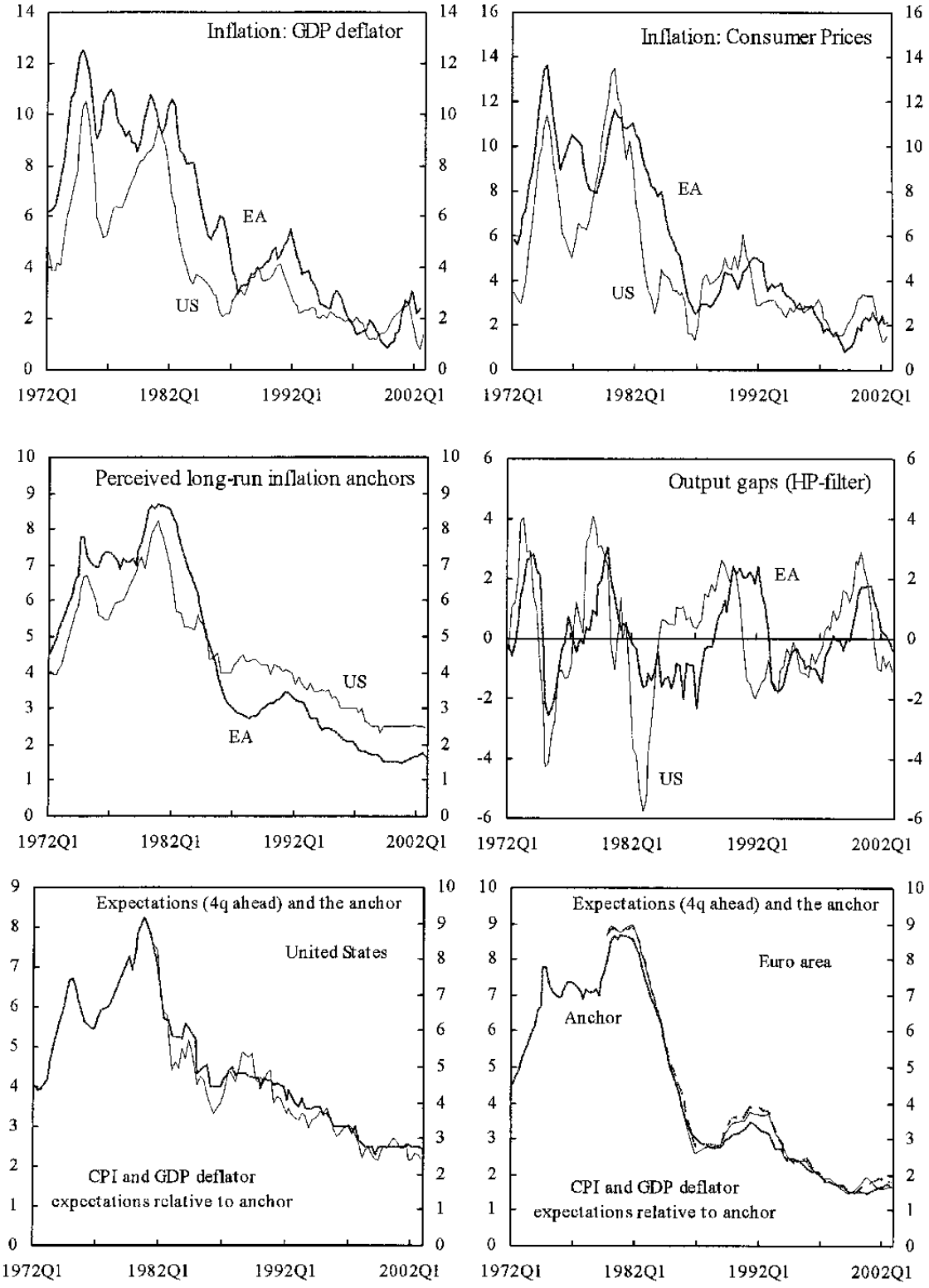
25. For the euro area, the half-yearly IMF forecasts of inflation five years ahead going back to the Summer 1990 WEO were reconstructed (using the same approach for the U.S. yields numbers similar to those in the Philly Fed surveys). Data for the quarters in between the half-yearly observations are interpolated. Since these data are not readily available before 1990, a separate method is used to construct the long-run inflation anchor prior to 1990, as described in Appendix I.

26. Short-run inflation expectations for the euro area are based on OECD forecasts which go back to 1980 (kindly provided by Marita Paloviita of the Bank of Finland, and described in Paloviita (2002)). Data for the quarters in between the annual observations are interpolated. Imperfections in the measures used for survey expectations in the euro area, compared to those readily available for the United States, warrant some degree of caution in evaluating the results of the various Phillips curve regressions presented below.

27. Inflation measured by the GDP deflator tended to be higher in the euro area than in the United States until the mid-1990s (Figure 1). Inflation came down less rapidly in the euro area following the first as well as the second oil crises, and again in the latest economic downturn, suggesting a priori that inflation is inherently more sluggish or that output gaps have been smaller in the euro area. These characteristics are broadly confirmed for consumer price inflation.

28. Inflation in the U.S. tends to be higher on the CPI measure than for the GDP deflator (by an average of 0.7 percent since 1980, but slightly less in recent years). The long-run inflation anchor for the U.S. has come down to 2.5 percent for CPI inflation, which thus

Figure 1. Euro Area and United States: Inflation, Survey Expectations, and Output Gaps, 1972-2002



corresponds to 1.8 percent (or slightly more) for the GDP deflator. The long-run expectation for the euro area currently stands at around 1.8 percent for both the GDP and the private consumption deflators.

29. The HP-filtered output gap in the United States showed much larger swings than in the euro area in the 1970s and 1980s; amplitudes were of comparable magnitudes in the early 1990s; while the recent downturn set in earlier and was more pronounced in the U.S. (IMF output projections to 2007 were used to mitigate the end-point problem of the HP filter).

30. In both the euro area and the U.S., expected inflation four quarters ahead has remained close to the estimated long-run anchors throughout the sample period.

F. Results

How inflation relates to its own lags (univariate methods)

31. Following Kozicki and Tinsley (2003) and others, inflation persistence is measured as the sum of coefficients from an estimated AR(4) model of inflation.

32. The results are summarized in Table 1 (for a fuller version including unit root tests for inflation, see Table 2):

Table 1. Univariate Inflation Persistence

Estimation sample	Inflation		Inflation Deviations	
	EA	**U.S.**	**EA**	**U.S.**
GDP deflator				
Full sample (1971-2002)	0.97	0.94	0.82	0.85
High inflation (1971-85)	0.86	0.87	0.76	0.84
Low inflation (1986-2002)	0.82	0.85	0.60	0.52
Recent (1995-2002)	0.55	0.54	0.45	0.45
Priv Cons deflator				
Full sample (1971-2002)	0.96	0.89	0.83	0.76
High inflation (1971-86)	0.87	0.83	0.74	0.77
Low inflation (1986-2002)	0.85	0.59	0.63	0.41
Recent (1995-2002)	0.51	0.44	0.59	0.45

Persistence is defined as the sum of the coefficients in an AR(4) model of inflation.

- In the full sample, inflation is highly persistent for both the euro area and the U.S., and slightly more so for the euro area (sum of coefficients of 0.96-0.97) than the U.S. (0.89 and 0.94 for the CPI and the GDP deflator, respectively). For this sample, standard tests cannot reject the hypothesis that inflation has a unit root.

- However, much of the observed persistence owes to low-frequency movements in the long-run inflation anchor. When inflation is measured in deviations from the perceived long-run inflation anchor standard tests reject the random walk hypothesis (Table 2), and the measure of persistence declines to 0.82-0.83 for the euro area and 0.76-0.85 for the U.S.

- In both the euro area and the United States, persistence has fallen sharply since the mid-1990s to 0.51-0.55 for the euro area and 0.44-0.54 for the United States. The results using inflation deviations suggest that the lower recent persistence reflect not only a more stable anchor, but also a closer centering of actual inflation on the monetary objective than before.

Table 2. Autoregression: Inflation Explained by Constant and Four Lags of Itself
(inflation is qoq; persistence is measured by the sum of autoregressive coefficients).

Euro Area	*Inflation*							*Deviations from long-run anchor*						
	Avg. infl.	S.E.	Sum of Coeff.	R-sq	st dev	DW	Unit root?	Avg. infl.	S.E.	Sum of Coeff.	R-sq	st dev	DW	Unit root?
GDP deflator														
Full sample (1971-2002)	5.8	3.5	0.97	0.88	1.25	1.82	n.r	1.3	1.6	0.82	0.51	1.14	1.96	**
High inflation (1971-85)	8.9	2.2	0.86	0.58	1.50	1.65	n.r.	2.2	1.7	0.76	0.44	1.35	1.92	**
Low inflation (1986-2002)	3.0	1.5	0.82	0.60	0.95	1.98	*	0.6	1.0	0.60	0.25	0.89	1.97	**
Semi-EMU (1995-2002)	1.9	1.0	0.55	0.20	0.91	1.99	**	0.1	0.9	0.45	0.14	0.89	1.99	**
Priv Cons deflator														
Full sample (1971-2002)	5.7	3.6	0.96	0.90	1.14	2.00	n.r	1.3	1.6	0.83	0.60	1.06	1.93	**
High inflation (1971-86)	8.9	2.5	0.87	0.72	1.36	1.97	n.r.	2.2	1.8	0.74	0.54	1.26	1.89	*
Low inflation (1986-2002)	2.9	1.2	0.85	0.59	0.81	2.02	*	0.5	0.9	0.63	0.28	0.78	2.02	**
Semi-EMU (1995-2002)	2.0	0.8	0.51	0.42	0.66	1.95	**	0.2	0.8	0.59	0.32	0.67	1.98	**
United States	*Inflation*							*Deviations from long-run anchor*						
	Avg. infl.	S.E.	Sum of Coeff.	R-sq	st dev	DW	Unit root?	Avg. infl.	S.E.	Sum of Coeff.	R-sq	st dev	DW	Unit root?
GDP deflator														
Full sample (1971-2002)	4.1	2.6	0.94	0.83	1.10	1.97	n.r	-0.4	1.5	0.85	0.57	1.00	1.88	**
High inflation (1971-85)	6.2	2.4	0.87	0.70	1.37	2.00	n.r.	0.4	1.8	0.84	0.55	1.25	1.85	n.r.
Low inflation (1986-2002)	2.4	1.0	0.85	0.47	0.78	1.90	**	-1.0	0.8	0.52	0.14	0.74	1.91	**
1995-2002	1.7	0.8	0.54	0.14	0.77	1.75	**	-1.0	0.8	0.45	0.13	0.78	1.78	**
CPI														
Full sample (1971-2002)	4.8	3.2	0.89	0.77	1.58	1.98	*	0.3	2.2	0.76	0.56	1.52	1.99	**
High inflation (1971-85)	6.8	3.5	0.83	0.75	1.79	2.01	n.r.	1.0	2.8	0.77	0.63	1.77	2.00	*
Low inflation (1986-2002)	3.0	1.5	0.59	0.33	1.27	1.89	**	-0.4	1.3	0.41	0.21	1.21	1.93	**
1995-2002	2.4	1.0	0.44	0.36	0.88	1.88	**	-0.3	1.0	0.45	0.37	0.87	1.86	*

Unit root tests: * (**) means the hypothesis of a unit root can be rejected at the 5 percent (1 percent) level. "n.r." means not rejected.

Inflation and output in bivariate VARs

33. The second step in the empirical strategy consists in estimating unrestricted VARs in output growth and inflation.[6] Figures 2 and 3 show the associated impulse responses of inflation (and cumulated inflation) to shocks to, respectively, output growth and inflation itself. The main findings are:

- In the full sample going back to 1971, the response of prices to *output shocks* is about twice as large in the euro area than in the United States. Plausibly, this could reflect less pronounced monetary stabilization of inflation and stronger wage and price responses to unforeseen output movements than in the United States for the earlier part of the sample period (the simple VAR does not allow for possible asymmetries in the response to positive and negative output shocks, respectively).

- The euro area exhibits a somewhat larger response of inflation to *price shocks* than in the United States. Plausibly, that could be related to a larger degree of monetary accommodation of price shocks and/or more pronounced real wage rigidities and formal wage indexation whereby price shocks had second-round effects and led to price-wage spirals.

- In the shorter and more recent sample (1987-2002; lower half of the page), the estimated impulse responses are essentially identical in the euro area and the United States. This might suggest that monetary policy responses for the euro-area aggregate had become more akin to the United States as the ERM commitment hardened among Germany's partners, and as wage indexation systems were reined in while structural reforms alleviated real rigidities.

The results, therefore, do not point to any clear conclusions that inflation responds less to output movements or that price shocks tend to become more ingrained in inflation in the euro area than in the United States, at least not in the sample since the mid- to late 1980s.[7]

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[6] The key results reported here were confirmed in alternative VAR-specifications in the output gap and inflation, or with inflation deviations instead of actual inflation.

[7] If the underlying mix of supply and demand shocks is different between the United States and the euro area (as suggested by some of the results in Chapter II of this paper), then the simple shocks to output and prices in an unrestricted VAR considered here may not be comparable between the euro area and the United States.

Figure 2: Impulse Responses Compared: Euro Area and United States, 1971-2002

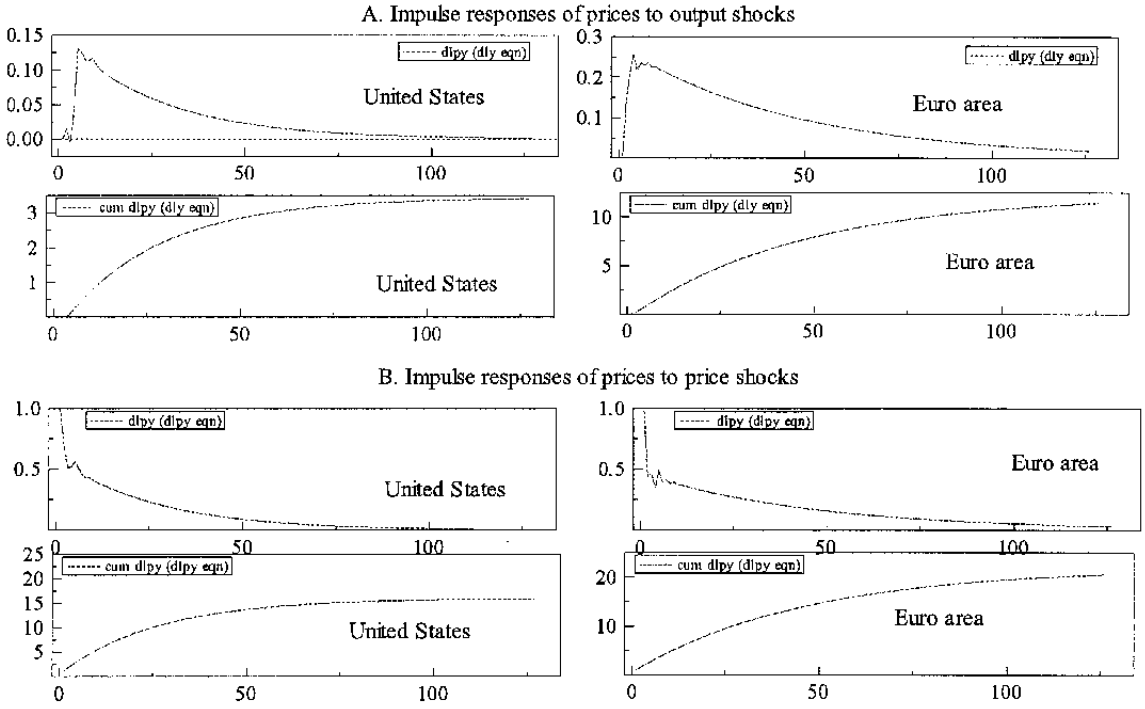
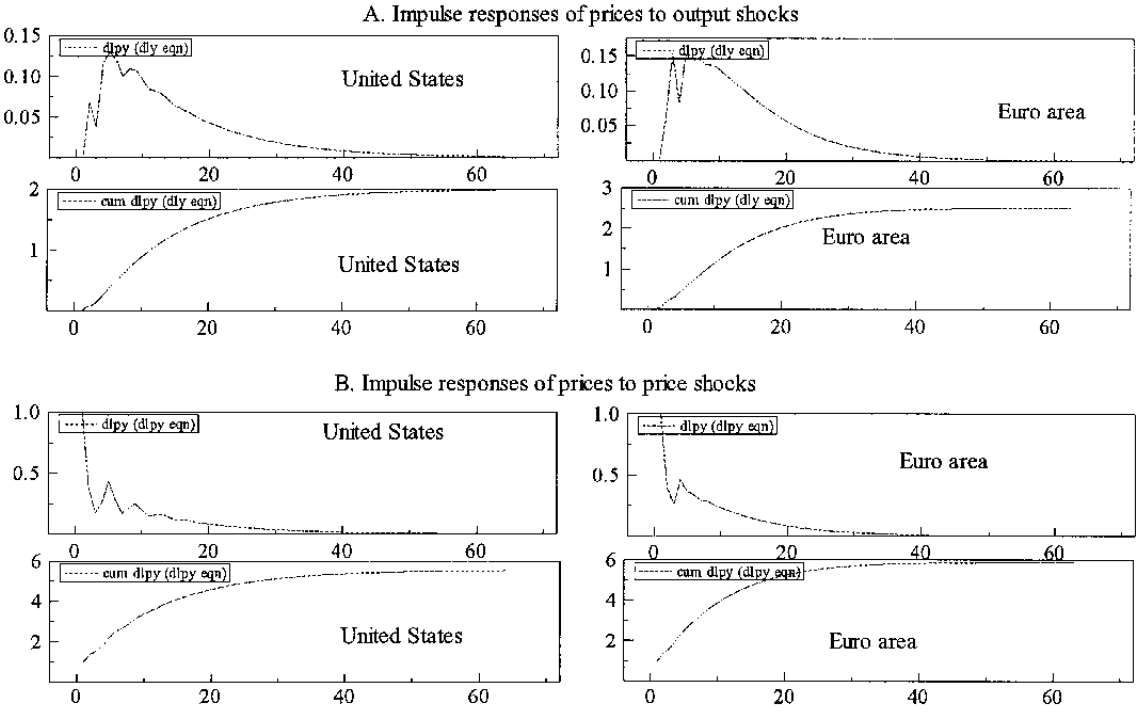


Figure 3: Impulse Responses Compared: Euro Area and United States, 1987-2002



Phillips-curve models: the role of lagged inflation and the coefficient on the output gap

34. The third element in the empirical strategy consists of comparing Phillips curve specifications for the euro area with the United States.

35. The literature on the New Keynesian Phillips curve has generally found that, when using rational expectations assumptions for inflation, the addition of lagged inflation was necessary to match observed persistence in the U.S. and euro area data (e.g., Fuhrer and Moore (1995), Fuhrer (1997), Coenen and Wieland (2002)).[8] However, as shown by Roberts (1998) for U.S. data, when real time survey expectations of inflation are used as a measure of expectations, the need for lagged inflation is obviated. In Roberts' view, this has the interpretation that the observed persistence in inflation is related to expectations formation rather than inherent features. (Although one might surmise that expectations will take account of structural features, such as whether inflation responds quickly to the output gap or not).

Phillips-curve estimates

36. The New Keynesian Phillips Curve as well as the hybrid specification was estimated to see if lagged inflation adds any explanatory power. Also reported are estimates of a more traditional expectations-augmented Phillips curve and the simple accelerationist Phillips curve to compare their (in sample) performance relative to the NKPC.

37. To check for robustness, two measures of the inflation rate were used, namely the GDP deflator and consumer prices. Moreover, estimates were derived for two measures of the output gap, namely an HP-filter gap (using a smoothing coefficient of 6400) and a series generated from the IMF country desks' output gap estimates for euro area countries. Expectations and lagged inflation are measured alternatively over 1 quarter, as in many empirical implementations for the U.S., or over four quarters, since the concept of year-on-year inflation is more prominent in European price and wage setters' information set, and it is closer to the one-year ahead horizon for which inflation projections are available (Fuhrer (1997) uses average inflation over three quarters for the United States). The regressions have been run for a long and a short (low inflation) sample. The import price deflator was used to control for import price (oil and exchange rate) shocks.[9]

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[8] When using unit labor costs as the proxy for marginal costs instead of the output gap, Gali, Gertler, and Lopez-Salido (2002) find a better fit for the pure NKPC, although even here some degree of persistence appears to improve the fit.

[9] In selecting lags of the output gap and import price variables, I follow the general-to-specific modeling approach advocated by David Hendry and others (see e.g., Hendry (1995)) and implemented through automated model selection procedures in PCGETS. This procedure selects the 'best' model on a range of objective criteria, thereby eliminating the temptation for the researcher to succumb to extensive data mining.

38. The results, summarized in Tables 3 (long sample) and 4 (shorter sample), imply that:

- The role of lagged inflation does not appear to be different between the euro area and the United States. In six out of eight cases, the hybrid specification reduces to the New Keynesian Phillips curve when the PCGETS automated model selection procedures are applied; only in two instances does lagged inflation appear to be a useful and significant addition to the equation. That applies to both the U.S. and the euro area. Thus, the results suggest that the role of lagged inflation is not materially different in the euro area when expectations are measured through survey expectations (the redundancy of lagged inflation when survey measures are used for expectations confirms Roberts' results for the U.S. (1997, 1998)).

- The coefficients on the output gaps do not appear significantly different in the euro area relative to the United States, but the impact is faster (one quarter earlier) in the United States. For the euro area, the coefficients on the output gap in the New Keynesian specifications range from 0.14-0.20, and for the United States from 0.10-0.24 (with only few specifications indicating more than one significant lag of the output gap in such a way that inflation depends not only on the level but also the change in the gap).[10]

- The New Keynesian Phillips curve fit the data better than the accelerationist or expectations-augmented specifications in all specifications, and (as stated above) only four out of sixteen have the hybrid model adding useful information to the NKPC.

Expectations formation

39. The conclusion that projected inflation performs better than lagged inflation in the Phillips curve estimations does not preclude that the inflation projections already incorporate a higher degree of inertia in inflation in the euro area than in the United States.

40. Two simple tests were conducted to look for signs that this might be the case. (These exercises should be taken with a grain of salt, since the degree of multicollinearity between lagged inflation, expected inflation, and the long-run anchor is high, and may affect the robustness of the coefficient estimates.)

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[10] The finding of similar persistence-related parameters between the U.S. and the euro area is not unusual in the more recent Phillips curve literature. Coenen and Wieland (2002) find that, among three popular contracting specifications, euro-area inflation dynamics are best explained by Taylor-style contracts, while the more inertial Fuhrer-Moore contracts fit U.S. data better, and the coefficient on the output gap is generally higher in the euro area than in the U.S. estimates. Gali, Gertler and López-Salido (2000) find that a purely forward-looking NKPC specification fits euro-area inflation remarkably well, possibly superior to U.S. data, and infer that inflation in the euro area may be less inertial than in the U.S.

Table 3. Phillips Curve Estimates; Euro Area and United States, 1979-2002

Euro Area 1/

	Coefficients						Regr. Stats		Hybrid
	infl (-1)	dlpm	dlpm (-t)	gap (-1)	gap (-2)	infl (+1)	S.E.	R-sq	redux to NKPC? 2/
Private consumption deflator; expectations and lagged inflation measured over 1 quarter									
Accelerationist	0.88	0.09	-0.05				0.91	0.91	
Expectations-augmented		0.08		0.25		0.87	0.71	0.94	
New Keynesian		0.07		0.18		0.95	0.71	0.95	
Hybrid	-0.21	0.07		0.20		1.17	0.71	0.95	yes
Private consumption deflator; expectations and lagged inflation measured over 4 quarters									
Accelerationist	0.83	0.08		0.19			0.74	0.94	
Expectations-augmented		0.07		0.26		1.07	0.67	0.95	
New Keynesian		0.06		0.19		1.10	0.65	0.95	
Hybrid	0.02	0.06		0.19		1.07	0.66	0.95	yes
GDP deflator; expectations and lagged inflation measured over 1 quarter									
Accelerationist	0.85	-0.06	0.09				0.98	0.88	
Expectations-augmented		-0.06	0.07	0.27		0.96	0.89	0.90	
New Keynesian		-0.07	0.08	0.20		0.99	0.85	0.91	
Hybrid	0.18	-0.07	0.08	0.17		0.80	0.85	0.91	yes
GDP deflator; expectations and lagged inflation measured over 4 quarters									
Accelerationist	0.91	-0.07	0.10	0.20			0.89	0.90	
Expectations-augmented		-0.08	0.04	0.26		1.14	0.82	0.92	
New Keynesian		-0.08	0.03	0.19		1.18	0.79	0.92	
Hybrid	-0.10	-0.08	0.03	0.18		1.31	0.80	0.92	yes

United States

	infl (-1)	dlpm	dlpm (-t)	gap	gap (-1)	infl (+1)	S.E.	R-sq	Hybrid redux to NKPC? 2/
Consumer price index; expectations and lagged inflation measured over 1 quarter									
Accelerationist	0.68	0.11		0.55	-0.52		1.47	0.74	
Expectations-augmented		0.12				0.89	1.13	0.49	
New Keynesian		0.06		0.19		1.18	1.09	0.64	
Hybrid	0.03	0.06		0.19		1.14	1.09	0.64	yes
Consumer price index; expectations and lagged inflation measured over 4 quarters									
Accelerationist	0.76	0.12		0.47	-0.32		1.26	0.81	
Expectations-augmented		0.12				0.86	1.15	0.47	
New Keynesian		0.08	0.02	0.26	-0.06	1.08	1.17	0.59	
Hybrid	0.37	0.10	0.02	0.45	-0.28	0.65	1.15	0.61	no
GDP deflator; expectations and lagged inflation measured over 1 quarter									
Accelerationist	0.82		0.05				0.85	0.85	
Expectations-augmented		0.03	0.03			0.86	0.79	0.86	
New Keynesian			0.02	0.10		1.01	0.71	0.89	
Hybrid	0.10		0.02	0.09		0.90	0.71	0.89	yes
GDP deflator; expectations and lagged inflation measured over 4 quarters									
Accelerationist	0.82	0.03	0.03	0.11			0.74	0.88	
Expectations-augmented		0.03	0.04			0.83	0.79	0.86	
New Keynesian			0.03	0.11		1.00	0.73	0.89	
Hybrid	0.37	0.03	0.03			0.51	0.71	0.89	no

1/ Since the expectations series is not available before, the sample is 1980-2002.

2/ Denotes cases in which lagged inflation is insignificant and automated model selection in PCGETS would reduce the model to the New Keynesian specification.

All coefficients are significant at the 5 percent level, except lagged inflation terms in the hybrid models in those cases where it reduces to the NKPC (where it says "yes" in the last column).

Table 4. Phillips Curve Estimates; Euro Area and United States, 1987-2002

Euro Area

	Coefficients						Regr. Stats		Hybrid
	infl (-1)	dlpm	dlpm (-t)	gap (-1)	gap (-2)	infl (+1)	S.E.	R-sq	redux to NKPC? 2/
Private consumption deflator; expectations and lagged inflation measured over 1 quarter									
Accelerationist	0.73	0.12	-0.09	-0.40	0.55		0.74	0.69	
Expectations-augmented		0.12			0.20	0.96	0.63	0.76	
New Keynesian		0.12	-0.04	0.14		0.99	0.62	0.77	
Hybrid	-0.08	0.12	-0.04	0.14		1.08	0.63	0.77	yes
Private consumption deflator; expectations and lagged inflation measured over 4 quarters									
Accelerationist	0.92	0.11		0.14			0.66	0.74	
Expectations-augmented		0.09		0.17		1.34	0.62	0.77	
New Keynesian		0.08		0.16		1.12	0.65	0.75	
Hybrid	0.41	0.10		0.17		0.62	0.62	0.77	no
GDP deflator; expectations and lagged inflation measured over 1 quarter									
Accelerationist	0.71	-0.08	0.07	0.17			0.88	0.62	
Expectations-augmented			0.08	0.27		0.95	0.77	0.70	
New Keynesian			0.06	0.19		0.98	0.76	0.71	
Hybrid	-0.12		0.07	0.20		1.10	0.76	0.71	yes
GDP deflator; expectations and lagged inflation measured over 4 quarters									
Accelerationist	0.91		0.08	0.20			0.78	0.69	
Expectations-augmented		-0.05	0.05	0.23		1.13	0.76	0.71	
New Keynesian		-0.06	0.04	0.18		1.15	0.73	0.73	
Hybrid	0.26	-0.05	0.05	0.18		0.84	0.73	0.73	no

United States

	infl (-1)	dlpm	dlpm (-t)	gap	gap (-1)	infl (+1)	S.E.	R-sq	Hybrid redux to NKPC? 2/
Consumer price index; expectations and lagged inflation measured over 1 quarter									
Accelerationist	0.46	0.11			0.16		0.87	0.63	
Expectations-augmented		0.10			0.22	0.93	0.82	0.66	
New Keynesian		0.07			0.22	0.95	0.75	0.72	
Hybrid	0.14	0.08			0.18	0.81	0.75	0.72	yes
Consumer price index; expectations and lagged inflation measured over 4 quarters									
Accelerationist	0.56	0.12	0.03		0.18		0.84	0.67	
Expectations-augmented		0.09			0.25	0.91	0.82	0.67	
New Keynesian		0.08			0.24	0.93	0.77	0.71	
Hybrid	0.17	0.08			0.20	0.76	0.76	0.71	yes
GDP deflator; expectations and lagged inflation measured over 1 quarter									
Accelerationist	0.61	0.06					0.71	0.57	
Expectations-augmented			0.03		0.18	0.82	0.62	0.67	
New Keynesian		-0.04	0.04		0.17	0.84	0.61	0.69	
Hybrid	0.15	-0.03	0.04		0.15	0.70	0.61	0.69	yes
GDP deflator; expectations and lagged inflation measured over 4 quarters									
Accelerationist	0.93		0.05		0.16		0.65	0.64	
Expectations-augmented		-0.03	0.04		0.19	0.82	0.63	0.66	
New Keynesian		-0.04	0.04		0.17	0.83	0.58	0.72	
Hybrid	0.13	-0.03	0.04		0.15	0.72	0.58	0.72	yes

2/ Denotes cases in which lagged inflation is insignificant and automated model selection in PCGETS would reduce the model to the New Keynesian specification.

All coefficients are significant at the 5 percent level, except lagged inflation terms in the hybrid models in those cases where it reduces to the NKPC (where it says "yes" in the last column).

41. First, the first set of estimates tries to determine the degree to which inflation expectations have been anchored on the perceived long-run objective of the monetary authorities relative to being determined by lagged inflation. The results show that expectations of inflation four quarters ahead have been fairly well aligned on the perceived long-run inflation objective (if not necessarily the stated objectives) of the monetary authorities, with a weight several times as high as that on lagged inflation (Table 5). The results also indicate that expectations have been better aligned on the anchor in the more recent sample since 1990 than for the longer sample since 1981Q3 for which U.S. data are available. Euro-area expectations have been only slightly less well aligned on the anchor with a coefficient on lagged inflation of 0.2-0.25 compared to a U.S. coefficient on lagged inflation in the range of 0.1-0.2.

Table 5. Expectations: Well-Anchored or Backward-Looking?

	Constrained estimates				Unconstrained estimates			
	Anchor	Lagged inflation	Sum	R-sq	Anchor	Lagged inflation	Sum	R-sq
United States, 1981(3)-2002								
CPI	0.73	0.27	1.00	0.82	0.83	0.25	1.08	0.97
GDP deflator	0.85	0.15	1.00	0.93	0.80	0.20	1.00	0.95
United States, 1990-2002								
CPI	0.81	0.19	1.00	0.73	0.77	0.21	0.98	0.90
GDP deflator	0.90	0.10	1.00	0.92	0.88	0.08	0.96	0.91
Euro Area, 1990-2002								
Cons. Deflator	0.75	0.25	1.00	0.95	0.80	0.22	1.02	0.98
GDP deflator	0.81	0.19	1.00	0.92	0.87	0.15	1.02	0.97

42. The second set of estimates uses a small model of inflation expectations explained by its own lags and the output gap to see if the latter moved inflation expectations more or less quickly in the United States than in the euro area. The results suggest that a positive output gap (as measured ex post) tended to raise inflation expectations only moderately in the euro area, while a positive change in the output gap had a considerably larger effect in the United States (Table 6). The interpretation would be that inflation expectations in the United States reacted significantly to (largely unforeseen) movements in the output gap, while more sluggish price adjustment and more pervasive uncertainty about the level and stability of the NAIRU in the euro area implied more moderate revisions to inflation expectations when activity shifted gear.[11]

Table 6. Expectations and the Output Gap

	Coefficient estimates 1/		
	Gap	Dgap	Own lags 2/
United States	0.02	0.11	0.99
Euro area	0.02		0.97

1/ From a regression of inflation expectations on its own lags and lags of the output gap.
2/ Sum of coefficients on the own lags of inflation expectations.

[11] Additional estimates were derived for Phillips curve equations as in equation (1) above with lagged inflation and the long-run anchor standing in for survey expectations. However, due to the high collinearity between the perceived long-run anchor and lagged inflation, the coefficients were not robust to small changes in the sample or specifications, and the regressions were not able to uncover systematic differences in the degree to which expectations had been aligned on the anchor in the euro area relative to the United States.

G. Conclusions

43. This investigation suggests that the inflation process in the euro area is only moderately more persistent or inertial than in the United States, if at all. The main findings are:

- Inflation persistence has been high in the historical data on *both* sides of the Atlantic. Much but not all of the observed persistence has been related to low-frequency shifts in economic agents' perceived long-run anchor of inflation. Persistence appears to have declined very significantly since some time in the mid-1990s, reflecting both a more constant long-run anchor and a closer alignment of actual inflation on the anchor.

- Historically, both price and output shocks appeared to have longer-lasting and more significant impacts on prices in the euro area than in the United States, but following the hardening of most euro area countries' commitment to stable exchange rates in the ERM after the mid to late 1980s, impulse responses look broadly similar between the United States and the euro area.

- Using survey measures of inflation expectations, the New Keynesian Phillips Curve matches the data quite well in both the U.S. and the euro area, suggesting little need to invoke structural characteristics in explaining persistence (although the survey expectations of inflation may already internalize some such features). There is evidence that inflation reacts more promptly to the output gap in the United States than in the euro area, yet the size of the coefficient on the output gap appears to be broadly the same.

- There are few signs that inflation expectations in the United States should have been significantly better aligned on the long-run inflation anchor rather than being influenced by past inflation, compared with the euro area. But inflation expectations in the United States do appear to react somewhat more strongly to changes in the output gap, presumably reflecting more flexible product and labor markets.

44. Taken at face value, the results imply that the faster reduction of inflation in the United States than in the euro area in the current economic downturn—as well as in the downturns of the 1970s and 1980s—is primarily due to output developments. In the recent instance, the output gap turned negative earlier and more sharply in the United States. In addition, a slightly earlier response of prices to the output gap, as well as a more rapid decline in inflation expectations as the economy weakened, likely played a role. Finally, erratic price shocks (food prices, euro changeover) and the pass through of earlier import price hikes hampered the reduction in inflation in the euro area in the 2000-2002 period.

45. The proposition that (structural) inflation persistence is not higher in the euro area than in the United States is in line with other evidence from the recent Phillips curve literature (e.g., Gali, Gertler, and López-Salido (2000) and Coenen and Wieland (2002)) but somewhat at odds with earlier evidence from monetary VAR models that suggested monetary policy actions have similar impacts on output in the euro area and the United States but smaller and more delayed effects on inflation in the euro area. Moreover, an earlier line of evidence pointing to higher (short-run) real wage rigidity in the euro area than in the United States—in the face of shocks to both prices and unemployment—also would suggest that inflation should be more sticky and harder to control in the euro area. A fuller examination of the role of expectations formation might produce insights that could help to reconcile this conflicting evidence.

Methods Used to Construct Long Run Inflation Anchors

For the U.S., survey expectations of inflation are readily available from the Federal Reserve Bank of Philadelphia's website. The long-run inflation expectations (10 year CPI inflation forecasts) are available since the fourth quarter of 1979.

For the euro area, the half-yearly IMF forecasts of inflation five years ahead going back to the Summer 1990 WEO were reconstructed (using the same approach for the U.S. would have yielded numbers similar to those in the Philly Fed surveys). Data for the quarters in between the half-yearly observations were interpolated.

Since these data are not readily available prior to 1990, the paper uses an alternative procedure to construct the long-run inflation anchor before that. In order to do this, I first construct a summary measure of monetary policy credibility following Laxton and Papa N'Diaye (2002) based on the level of the long-run nominal interest rate. With credibility varying between 1 at the point of the lowest long-term interest rate (RL_{min}) and 0 at the time of the highest long-term interest rate (RL_{max}), credibility is proxied by:

$$c = \frac{(RL - RL_{\max})^2}{((RL - RL_{\max})^2 + (RL - RL_{\min})^2)}$$

The observed long-run anchor in the 1990-2002 period is then regressed on actual inflation, HP-filtered inflation, and the said measure of central bank credibility, as well as an interaction term, which produces a reasonably good fit. The estimated equation is then used to retropolate the long-run anchor for the time before 1990. The advantage of using the credibility variable rather than simply using filtered and actual inflation is that the inflation in the 1970s and 1980s does not show up as anticipated or fully reflected in the long-run anchor. Applied to the U.S., the said method is roughly able to match the features of the U.S. survey expectations which are available back to 1979Q4, and for the period before that it lines up well with the long-run anchor estimated using shifting end-point Kalman filter techniques in Kozicki and Tinsley (2003) (a technique which is computationally heavy and requires fairly long time spans of back data).

Confidence that this method may be broadly appropriate is enhanced by the fact that the available short-term inflation expectations line up well with the estimated anchor for the euro area before 1990 and the United States before 1979Q4 in a manner that does not deviate systematically from the periods for which the long-run anchor is directly observed, see the two bottom panels of Figure 1 on page 11.

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II. Euro Area Business Cycles: The Role of Supply and Demand Disturbances[1]

A. Introduction

1. The identification and attribution of the sources of macroeconomic shocks have important implications in all areas of economic policy. If, for example, supply shocks are more important in the euro area than in the United States, this would argue for less activist demand management policies and more emphasis on structural policies. In particular, attempts to offset economic downturns that were due to negative supply shocks would have strong inflationary consequences.

2. The area's more recent growth performance has been affected by an inordinate number of economic shocks. These have included, inter alia, the impact of the monetary union itself, the global equity market boom and bust, weather and disease related food disruptions, oil price shocks, and sharp movements in the exchange rate. An important question is whether, on balance, these shocks been mostly supply related, thereby generating a reduction in the area's level of potential output? Or have they been predominantly demand-related shocks?

3. Attempts to identify the persistence of shocks have centered on the estimation of structural vector autoregressions (SVARs). Empirical research has focused on a few major euro-area countries and has tended to generate varying and sometimes conflicting results regarding the source of fluctuations and the degree of cross-country correlation of shocks. Moreover, apart from some recent research on the shock asymmetry of transition economies (relative to euro-area countries), there has been very little work on identifying shocks that affect the euro area aggregate economy.

4. Against this background, the purpose of this chapter is to examine the relative role of supply and demand shocks in driving macroeconomic fluctuations in the euro area. Section B takes stock of the existing literature on identifying supply and demand shocks in the euro area, with a particular focus on pinning down areas of agreement and disagreement. Section C describes the identification methodology using structural VARs. Section D introduces and analyzes the data. Section E presents the VAR results, and Section F concludes.

B. Literature on Identifying Supply and Demand Shocks in Europe

5. Most of the earlier literature focuses on individual EU countries. A number of authors using a variety of identification techniques, country datasets, and time periods have examined the dynamic behavior of output and prices in response to macroeconomic shocks (Table 1). Much of the work on shock dynamics took place in the early 1990s, as internal market integration was taking shape and developing, and as the list of possible early EMU entrants was being determined. At the same time, the imminent accession of ten transition countries to

[1] Prepared by Kevin Ross.

Table 1. Summary of Research on Supply-Demand Sources of Euro-Area Economic Fluctuations

Author(s)	Identification	Countries 1/	Period	Variables in VAR	Number and type of shocks	EA Outcomes 2/
Bayoumi and Eichengreen (1992)	SVAR (BQ)	**DE, F, B, NL, I, Es, Ire, P** Denmark, & U.K. as EC aggregate; Plus 6 EFTA (S, **A, Fl**, N, IC, Sw) & U.S., Japan, Can, Australia, N.Z. (22)	Annual 1960-88 1963-88 for EC aggregate	Real GDP & implicit GDP deflator	(2); supply and demand	**No clear domination of supply or demand shocks.**
Ahmed and Park (1994)	SVAR (BQ)	Australia, **A**, Can, **Fl, F, I**, U.K. (7)	Quarterly 1960-87 (subsets)	Domestic output foreign output, CPI, & trade balance	(4), 2 supply; 2 demand external and domestic supply; domestic absorption (fiscal) & price level (nominal money)	**Supply (A,F, I); Demand (Fl)**
Karras (1994)	SVAR (BQ)	**DE**, F, U.K. (3)	Quarterly 1957-88 (subsets)	Industrial production, CPI, oil (in U.S.$), real interest rate, employment	(5), labor supply, technology, oil price, & 2 aggregate demand shocks (not separately identified) linked to prices and real interest rates *AS shocks also separated into oil and non-oil AS	**Demand (F); Supply (DE)**
Karras (1993)	SVAR (BQ)	**I**, S, U.K.	Annual 1861-1987	Real GDP, CPI	(2), supply and demand	**Supply (S, U.K., I (but identification problems with Italy)**
Whitt, Jr (1995)	SVAR (BQ)	**DE, F, I, NL**, U.K. U.S., Can, Japan (8)	Monthly 1/60-7/92	Industrial production & wholesale prices	(2), supply & demand	**Supply (DE, F, NL); Demand (I)**
Bergman (1996)	SVAR common trends (BQ)	**DE**, S, U.K., U.S. Japan (5)	Quarterly 1960-90 (subsets)	GDP & CPI	(2) supply & demand Permanent shocks (labor force & productivity) affect level of output. Demand shocks are transitory.	**Demand (DE)**
Hartley and Whitt Jr. (2003)	Generalized Method of Moments	**DE, F, I, NL**, U.K., U.S. (6)	Quarterly 1960-98 (subsets)	Industrial production & producer prices	(4) temporary and permanet supply and demand shocks	**Demand shocks dominate in all 6 countries.**

1/ Country abbreviations are as follows: Austria (A); Belgium (B); Canada (Can); Demark (D); Finland (Fl); France (F), Germany (DE); Iceland (IC); Ireland (Ir); Italy (I); Netherlands (NL); New Zealand (NZ); Norway (N); Switzerland (Sw); United Kingdom (U.K.); United States (U.S.). Euro area countries are highlighted in bold.
2/ Determination on which shocks are the main driving factor behind output fluctuations.

the European Union (EU), the need to continually assess the integration progress of current EMU members, and a number of sizable shocks which have recently hit the euro area, have rekindled interest in the nature of shocks in EU countries.

6. A review of the literature in Table 1 suggests some preliminary conclusions:

- A clear and authoritative answer on which type of shock, aggregate supply or aggregate demand, dominates in explaining the majority of the fluctuations in output has not been achieved. A slight majority of the studies, however, appears to point toward demand shocks as dominating at very short horizons.

- Across countries, aggregate supply shocks appear to be positively correlated to those in Germany. However, there is very little evidence the correlation has increased over time, and it appears that across countries supply shocks may have become more correlated to French supply shocks over time, and less so to German ones.

- Aggregate demand shocks appear to be smaller and less correlated than supply shocks across euro area countries.

- Smaller periphery countries appear to face larger supply and demand shocks than core countries. At the same time, they also have more flexible wage and price systems that allow a less costly adjustment process.

C. The Blanchard-Quah (BQ) Structural VAR Methodology

7. The BQ methodology allows the identification of permanent and temporary structural shocks to a variable. This is achieved by imposing long-run restrictions on a VAR system while leaving short-run dynamics to be determined by the data. Assume the VAR model can be represented by an infinite moving average representation of a vector of variables x_t, with an equivalent number of structural shocks ε_t:

$$\Delta x_t = A_0\varepsilon_t + A_1\varepsilon_{t-1} + \ldots = \sum_{i=0}^{\infty} A_i\varepsilon_{t-i} \qquad (1)$$

In this setup, the A_i matrices represent the impulse response functions of the shocks to the elements of x, while the ε vector contains the supply and demand shocks. When x_t represents the changes of the logarithms of real output and prices, a more specific version of the model can be written as follows:

$$\begin{bmatrix} \Delta y_t \\ \Delta p_t \end{bmatrix} = \sum_{i=0}^{\infty} L^i \begin{bmatrix} a_{11i} & a_{12i} \\ a_{21i} & a_{22i} \end{bmatrix} \begin{bmatrix} \varepsilon_{st} \\ \varepsilon_{dt} \end{bmatrix} \qquad (2)$$

where

$$Var(\varepsilon_t) = \Sigma \qquad (3).$$

8. The fundamental shocks ε_{st} and ε_{dt} are assumed to be orthogonal and therefore, the variance-covariance matrix Σ is diagonal. The BQ framework contains the restriction that supply shocks have permanent effects on the level of output while demand shocks have only temporary effects—implying that the cumulative effect of demand shocks on the change in output must be zero. Both shocks are allowed to have permanent effects on the level of prices. This restriction means that the matrix of long-run moving average coefficients, $C(1)$ must be lower triangular:

$$\sum_{i=0}^{\infty} a_{11i} = 0 \qquad (4).$$

9. The structural VAR model defined by equations (2) and (4) can be estimated in its reduced form version by ordinary least squares. In typical VAR format, this means that each element of x_t is regressed on lagged values of all the elements of x, with the estimated coefficients represented by B. That is:

$$x_t = B_1 x_{t-1} + B_2 x_{t-2} + ... + B_n x_{t-n} + e_t \qquad (5)$$

where e_t represents residuals from the estimation of the reduced form VAR. Next, the following algebraic manipulation is used to find the matrix of long-run moving average coefficients:

$$x_t = (I - B(L))^{-1} e_t = (I + B(L) + B(L)^2 + ...+)\, e_t \qquad (6)$$

$$x_t = e_t + D_1 e_{t-1} + D_2 e_{t-2} + D_3 e_{t-3} + ... \qquad (7)$$

10. To move back to the structural model given by equations (2) and (4), the residuals from the reduced form VAR, e_t, must be transformed into supply and demand shocks ε_t. This is accomplished by the restricted factor matrix C, such that $e_t = C\varepsilon_t$. Given the two variable output growth and inflation case under consideration, four restrictions are required to define the four elements of C. Two of these restrictions are simple normalizations, which define the variance of the shocks ε_{st} and ε_{dt}. A third restriction comes from assuming that the supply and demand shocks are orthogonal. The final restriction regarding the temporary nature of demand shocks, uniquely defines the C matrix and implies equation (4) in the structural model. For the reduced form VAR, this means:

$$= \sum_{i=0}^{\infty} \begin{bmatrix} d_{11i} & d_{12i} \\ d_{21i} & d_{22i} \end{bmatrix} \begin{bmatrix} c_{11} & c_{12} \\ c_{21} & c_{22} \end{bmatrix} = \begin{bmatrix} .. & 0 \\ .. & .. \end{bmatrix} \qquad (8)$$

11. Although this restriction affects the response of output to the two shocks, it does not affect the impact of these shocks on prices. However, a basic aggregate supply (AS) and aggregate demand (AD) model (with a vertical long-run AS curve) implies that demand shocks should raise prices in both the short- and long-run, while supply shocks should lower

prices. In this model, a positive demand shock will result in a shift of the AD curve to the right, and in the short-run, to higher output and prices (Figure 1). In the long-run, the output increase is short-lived as the price level increases to generate a new equilibrium output at potential along the new AD curve. A positive supply shock shifts short and long-run AS curves to the right by the same amount (Figure 2). Thus, in the short as well as in the long run, prices decline as output expands.

12. Since these responses are not imposed, authors who have used the BQ model to identify supply and demand shocks, have also examined the impulse response functions for these patterns as a form of over-identifying restriction. Researchers have found these useful in interpreting the results and ensuring that output and prices respond in a theoretically correct way to supply and demand shocks. The same type of identification check will be performed here as well and used as guide in the determination of correctly identified shocks.

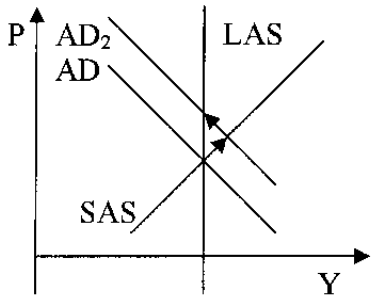


Figure 1: Demand Shock

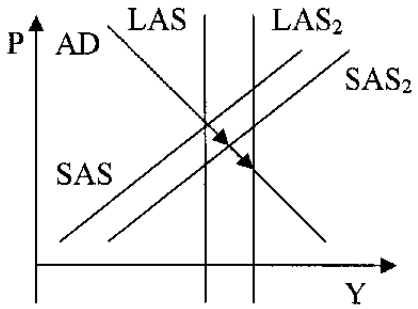


Figure 2: Supply Shock

D. Preliminary Data Analysis

13. Quarterly data on industrial production, real GDP, the GDP deflator, and consumer and producer prices were gathered for the euro area and for the United States. In addition, aggregates for the euro area (EA12), a "large country" version of the euro area comprised of Germany, France and Italy (EA3), and for the small periphery countries (EA9), were constructed for each of the variables. The maximum time span of the data runs from 1963:1 to 2002:3.

14. As a first step in the analysis, the stationarity properties of the logged data were examined using augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests for unit roots. In all cases an intercept and time trend were included in the tests. The results, presented in Table 2, suggest that in most instances, output series—both industrial production and real GDP—contain a unit root in levels but are stationary in their differences. Similarly, unit root tests on the producer price series imply that producer prices are stationary only in their logged first differences.

15. The results for real GDP deflator and CPI, however, indicate that in many countries these price series may remain non-stationary in their growth rates, (i.e., implying I(2) behavior), making their use in a bivariate VAR analysis problematic. Since all of the price series considered here are very much interrelated, one could assume that similar unit root properties exist, and given the low power of these tests, proceed under the assumption that the data generating process of prices is I(1). However, exploratory examination of the price impulse response functions (in the context of the VAR analysis) using these unadjusted GDP deflators and CPI series created problems in shock identification. Thus, these series were further tested for possible mean shifts and trend breaks, which can create the illusion of I(2)-type behavior. The results (not presented here) indicated that after adjusting for deterministic mean shifts and trend breaks using Perron's (1997) technique, both the CPI and GDP deflator inflation series could be considered stationary and usable in the next stage of the analysis.

Table 2. Unit Root Tests 1/
(1963:1 to 2002:3)

	IP		PPI		GDP		GDP Deflator		CPI	
	ADF	PP	ADF	PP	ADF	PP	ADF	PP	ADF	PP
					A. Levels					
EA12	-2.51	-2.91	-0.82	-0.21	-3.12	-2.80	-1.15	0.71	-1.63	0.31
EA3	-2.35	-2.86	-0.93	-0.43	-3.24	-3.07	-0.48	0.80	-1.63	0.21
EA9	-2.76	-2.94	-0.65	-0.04	-2.45	-2.71	-1.14	0.67	-1.76	0.46
U.S.	-3.44	-3.17	-0.21	-0.29	-3.66	-3.05	0.00	0.40	-1.06	-0.09
					B. First Differences					
EA12	-8.41	-8.36	-3.76	-4.96	-6.52	-10.89	**-2.16**	**-2.66**	**-1.75**	**-2.59**
EA3	-9.52	-9.50	-5.13	-5.13	-11.50	-11.52	**-2.52**	**-3.37**	**-1.77**	**-2.65**
EA9	-6.06	-9.49	**-3.16**	-7.17	-4.27	-7.28	**-2.17**	-3.76	**-1.56**	-4.10
U.S.	-6.74	-6.70	-6.60	-7.00	-8.48	-8.62	-3.75	-3.51	**-2.70**	-4.14

Source: Staff estimates.
1/ Augumented Dicky-Fuller (ADF) and Phillips-Perron (PP) tests with constant and time trend were calculated over the full sample (1963:1-2002:3). The 1, 5 and 10 percent critical values are -4.018, -3.439, and -3.143, respectively. The null hypothesis is that the level series contain a unit root. Rejections of the null hypothesis at the 5 percent level have been put in bold.

E. Empirical Results of the Structural VAR Analysis

16. A bivariate VAR model was estimated and structural shocks identified as discussed above. The number of lags was set to four since the Schwartz Bayesian information criterion indicated that all the models had an optimal lag length of either three or four. A uniform lag structure was chosen to allow comparisons across countries. In the analysis below, all shocks were normalized to a unit shock to the system. The impulse response function analysis using real GDP and GDP or CPI deflators on the full sample indicated that while the initial output response to positive demand shocks would be positive as expected, it would quickly turn negative before gradually dissipating, suggesting a problem with the identification restrictions. Therefore, the analysis below focuses on 3 output-price pairs—industrial

production and producer prices for both sample periods, and on real GDP and the GDP deflator for the period 1980:1 to 2002:3.

Impulse response functions

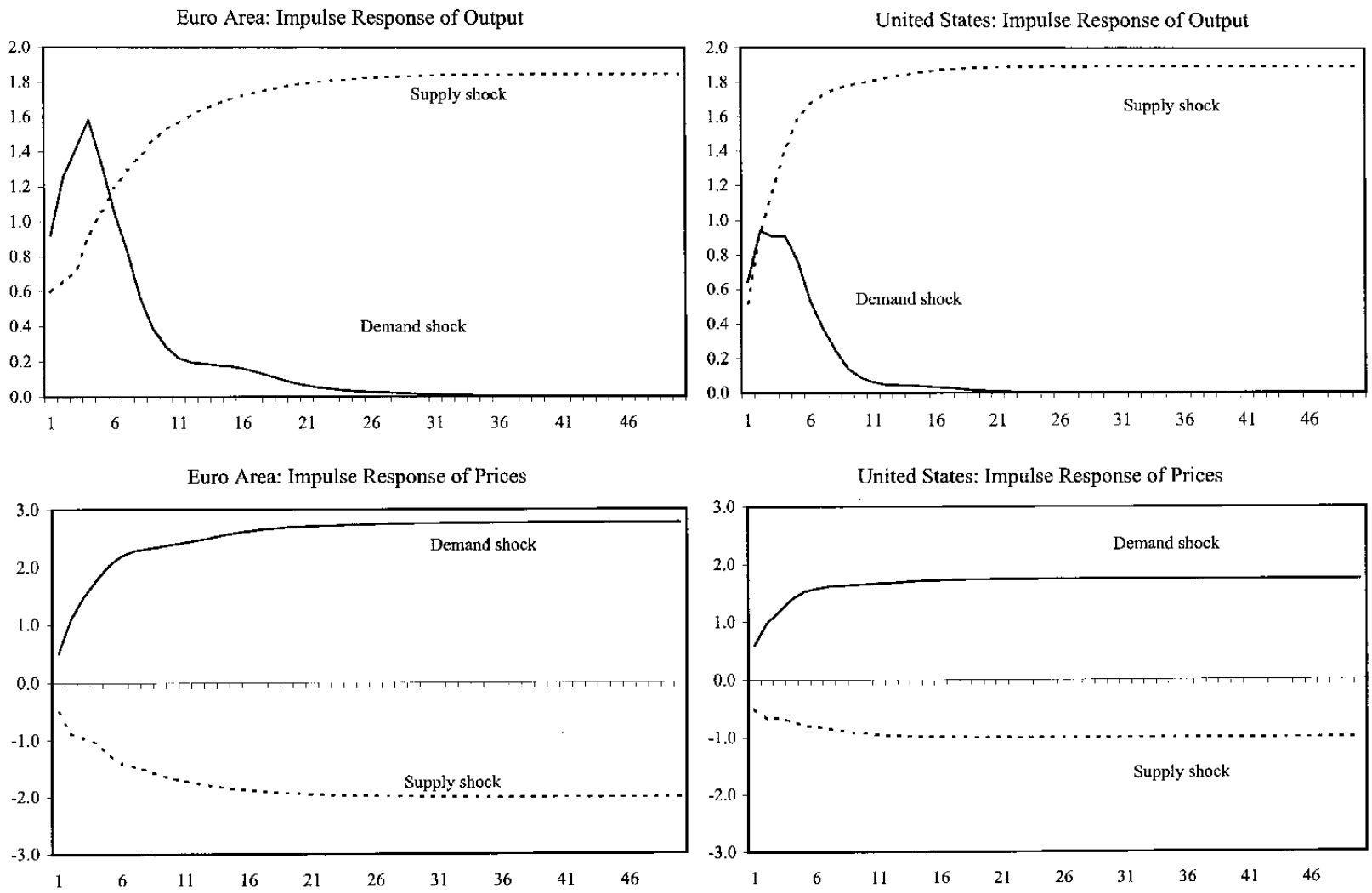
17. Figures 3-5 present the impulse response results for the euro area and the United States. In all instances, the estimation and simulation results are in line with the AS-AD framework discussed in Section C. That is, positive aggregate demand shocks are associated with increases in prices while aggregate supply shocks are associated with declines in prices. Also, the BQ restriction is reflected by the temporary effects of aggregate demand shocks on the level of output, while aggregate supply shocks have permanent effects.

18. A number of results can be distilled from these impulse response functions. First, in most cases, demand shocks appear to be more, or at least as important, for output as supply shocks in the short run. This is especially the case for the euro area using industrial production. Second, in general, disturbances appear to have more protracted effects in the euro area than in United States. For example, the impulse response function for the euro area using industrial production indicates that demand disturbances have large effects that peak within 4 quarters and then decline, leveling off at around 0.2 after 12 quarters but do not fully vanish until some 5-6 years. In the United States, the effects of demand shocks on output vanish after a little over two years. Third, the magnitude of the shocks on output differs between the United States and the euro area aggregates. For example, output effects from demand shocks in the first year appear to be about 50 percent larger in the euro area than in the United States when using industrial production. Supply shocks on output appear to be of equal size in the United States and the euro area. However, some of these differences may be the result of aggregation issues. In sum, while these impulse response function results are similar to Bayoumi and Eichengreen (1992a) and others, they do seem to indicate that the size of aggregate demand shocks in Europe may have increased.

Forecast error variance decompositions

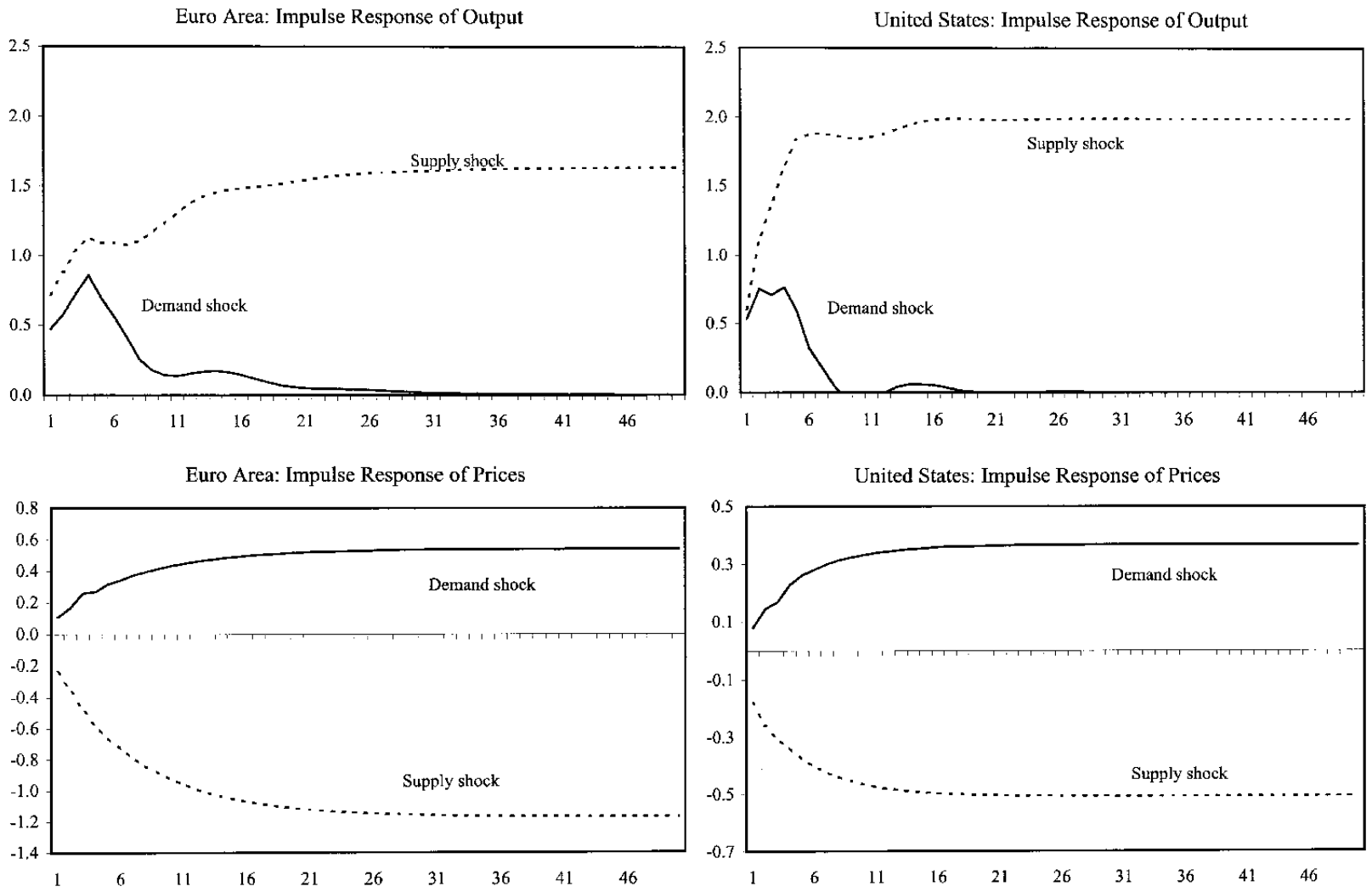
19. Table 3 contains the results of the output forecast error variance decompositions for the 3 output-price pairs; the table also reports results for the EA3 and EA9 aggregates. The numbers reveal the percentage of forecast errors that can be attributed to supply innovations at eight different forecast horizons: one to two quarters ahead (short-run); four to twelve quarters ahead (medium-run); and 20 to 36 quarters ahead (long-run). These forecast error variance decompositions (and impulse response functions) indicate the significance of the different shocks on average over the entire sample period.

Figure 3. Impulse Response Functions for the Euro Area and U.S.
(Industrial Production and Producer Prices; 1963.1-2002.3)



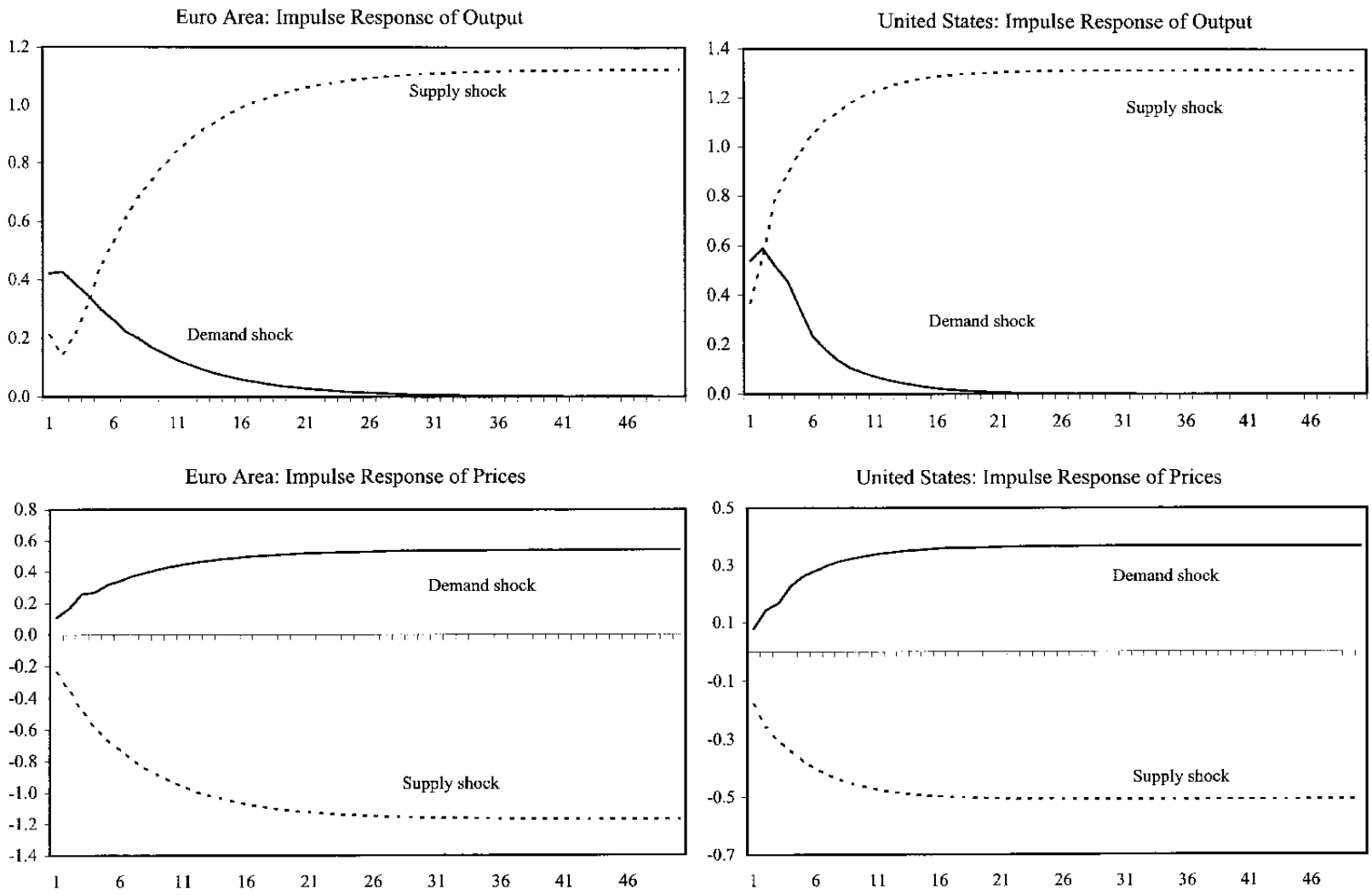
Sources: ECB; Eurostat; IMF; and own calculations.

Figure 4. Impulse Response Functions for the Euro Area and U.S.
(Industrial Production and Producer Prices; 1980.1-2002.3)



Sources: ECB; Eurostat; IMF; and own calculations.

Figure 5. Impulse Response Functions for the Euro Area and U.S.
(Real GDP and GDP Deflator; 1980.1-2002.3)



Sources: ECB; Eurostat; IMF; and own calculations.

Table 3. Forecast Error Variance Decomposition of Output 1/

	Relative contribution of supply shocks (%) Time horizon (quarters)								
	1	2	4	8	12	20	24	36	8
(Industrial Production and Producer Prices: 1963.1 to 2002.3)									
EA12	29.6	23.3	23.8	47.6	62.1	74.4	78.7	86.1	100
EA3	39.1	30.6	31.8	56.6	69.6	81.0	84.2	89.8	100
EA9	41.3	35.8	34.7	53.7	57.9	74.7	78.2	85.0	100
U.S.	39.2	53.8	60.1	79.7	87.6	93.3	94.6	96.6	100
(Industrial Production and Producer Prices: 1980.1 to 2002.3)									
EA12	70.1	70.0	66.7	74.7	83.4	91.3	93.1	95.9	100
EA3	77.9	76.5	73.0	79.8	87.2	93.5	94.9	97.0	100
EA9	52.1	49.2	48.5	60.8	70.8	82.5	85.8	91.2	100
U.S.	56.2	65.2	75.9	89.2	93.3	96.4	97.1	98.1	100
(Real GDP and GDP Deflator: 1980.1 to 2002.3)									
EA12	19.6	15.1	24.7	63.5	81.4	92.4	94.4	96.9	100
EA3	92.0	92.7	95.9	98.2	98.9	99.4	99.5	99.7	100
EA9	46.6	54.3	58.8	77.1	86.8	93.2	94.5	96.5	100
U.S.	31.9	41.0	62.5	82.9	90.1	94.9	96.0	97.5	100

Source: Staff estimates.

1/ Since supply and demand shock contributions add up to 100 percent, 100- minus these supply contributions represent the demand contribution. By definition of the BQ identification, the supply shock contribution must asymptotically go to 100 percent in the long-run.

20. For the period covering the last forty years, the results indicate that demand innovations are dominant in the very short-run in the euro area when using industrial production as a proxy for output. For the United States, the results suggest that demand innovations have a very short-run impact, with supply innovations by the second quarter explaining over 50 percent of output variance, again suggesting a relatively fast reaction to demand shocks.

21. Given the demand side pressures of the 1960s and the oil price shocks of the 1970s, an important question is how these results would change if the sample was limited to the 1980-2002 experience. In essence, those more turbulent periods may be dominating the overall outcomes, and thus their elimination should allow a better understanding of how the more recent shocks have been affecting output. The middle panel of Table 3 presents the forecast error variance for aggregates using industrial production and producer prices, but with the shorter sample period. The results imply a stronger dominance of supply shocks—above the 50 percent threshold—in determining output fluctuations at all horizons. This outcome indicates that sensitivity to sample period may be driving the different findings

found in the literature on which shock dominates output fluctuations. The bottom panel of Table 3 contains the results of using real GDP and the GDP deflator from 1980:1 to 2002:3. Here, the data aggregation issue appears to have a greater impact; demand innovations explain a sizable amount of output fluctuations at a short horizon for the EA12 aggregate, while the results for EA3 aggregate imply the opposite.

Historical decompositions: a more detailed look at the most recent experience

22. Using the estimates from the VAR model, it is also possible to calculate historical decompositions which measure the unconditional forecast error for each of the variables. This forecast is defined as the difference between the realized level of the variable and the unconditional forecast from the deterministic component of the VAR. Then the forecast errors in the level of each variable can be decomposed into components attributable to each of the shocks. Given our goal of identifying the most recent shock experience since the start of EMU, the focus will be on the decomposition of output forecast errors leading up to and since 1999.

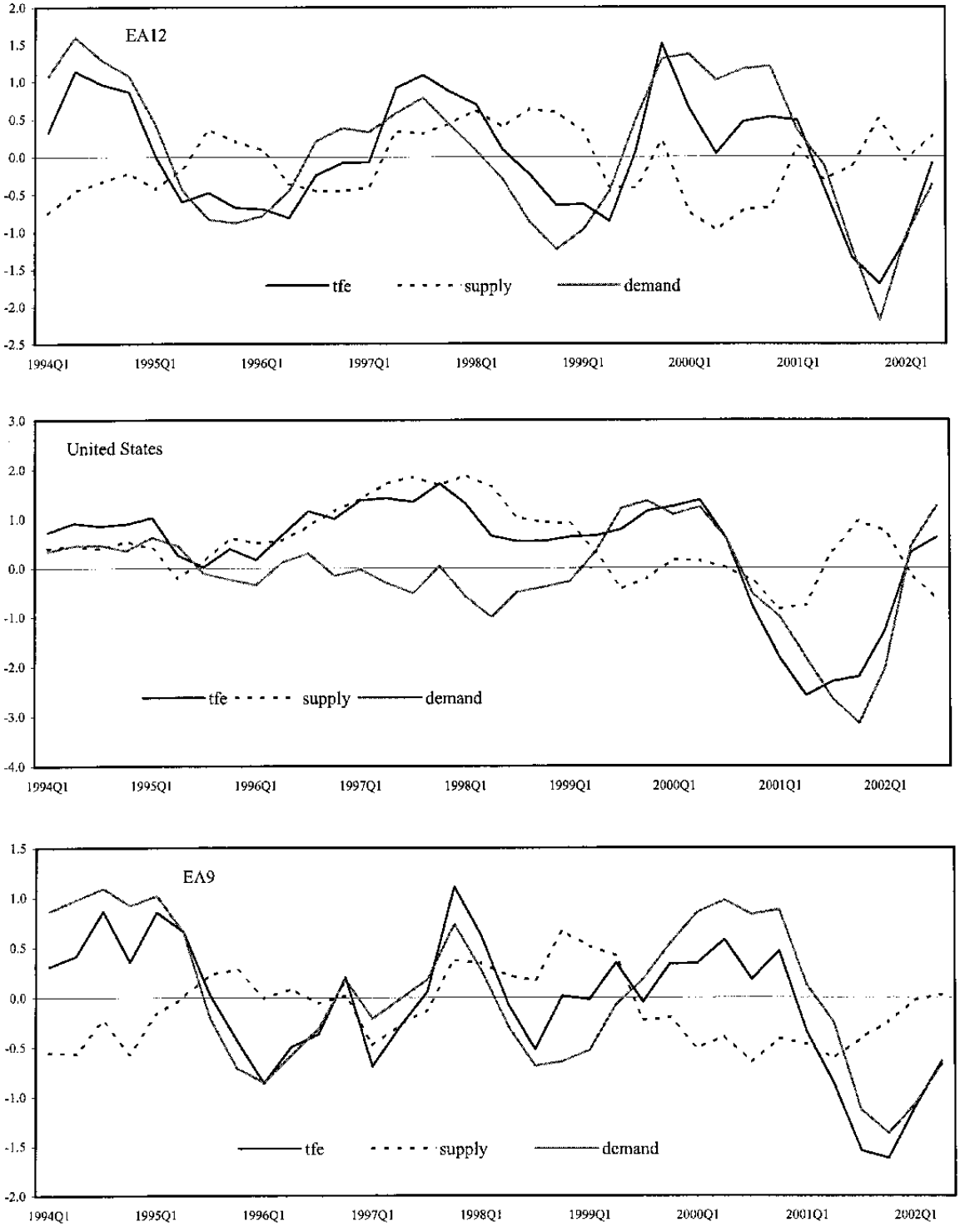
23. Figures 6 through 8 contain the decompositions for EA12 and EA9 aggregates as well as for the United States. Figure 6 shows the results using industrial production for the full sample period. For the euro area aggregates, a majority of output total forecast errors (tfe) in this period have been driven by demand shocks—in line with the previous evidence presented above. In the United States, demand innovations play an important role, but it is interesting to see that the build up and magnitude of the supply innovations that drove output since the mid-1990s.

24. Focusing on the 1999-2002 period only, for the euro area aggregates, supply innovations have played a role, remaining mostly negative since 2000. However, this particular decomposition clearly indicates that negative demand innovations were the main reason for the slowing in output growth, especially since mid-2001. Regarding the United States, the results indicate that negative supply innovations played a relatively minor role in reducing output growth.

25. The forecast error variance decompositions (Table 3) suggested that using the shorter sample period 1980-2002 markedly increases the dominance of supply shocks. Would a historical decomposition of recent output forecast errors attribute most of the variation to supply side innovations as well? To answer this question, the historical decomposition analysis was run using the shorter sample (Figure 7). Interestingly, the historical decomposition of the total forecast error for the euro area aggregates still tend to place greater emphasis on the demand disturbances. In the United States, however, there would appear to be more of an even mix of supply and demand side influences.

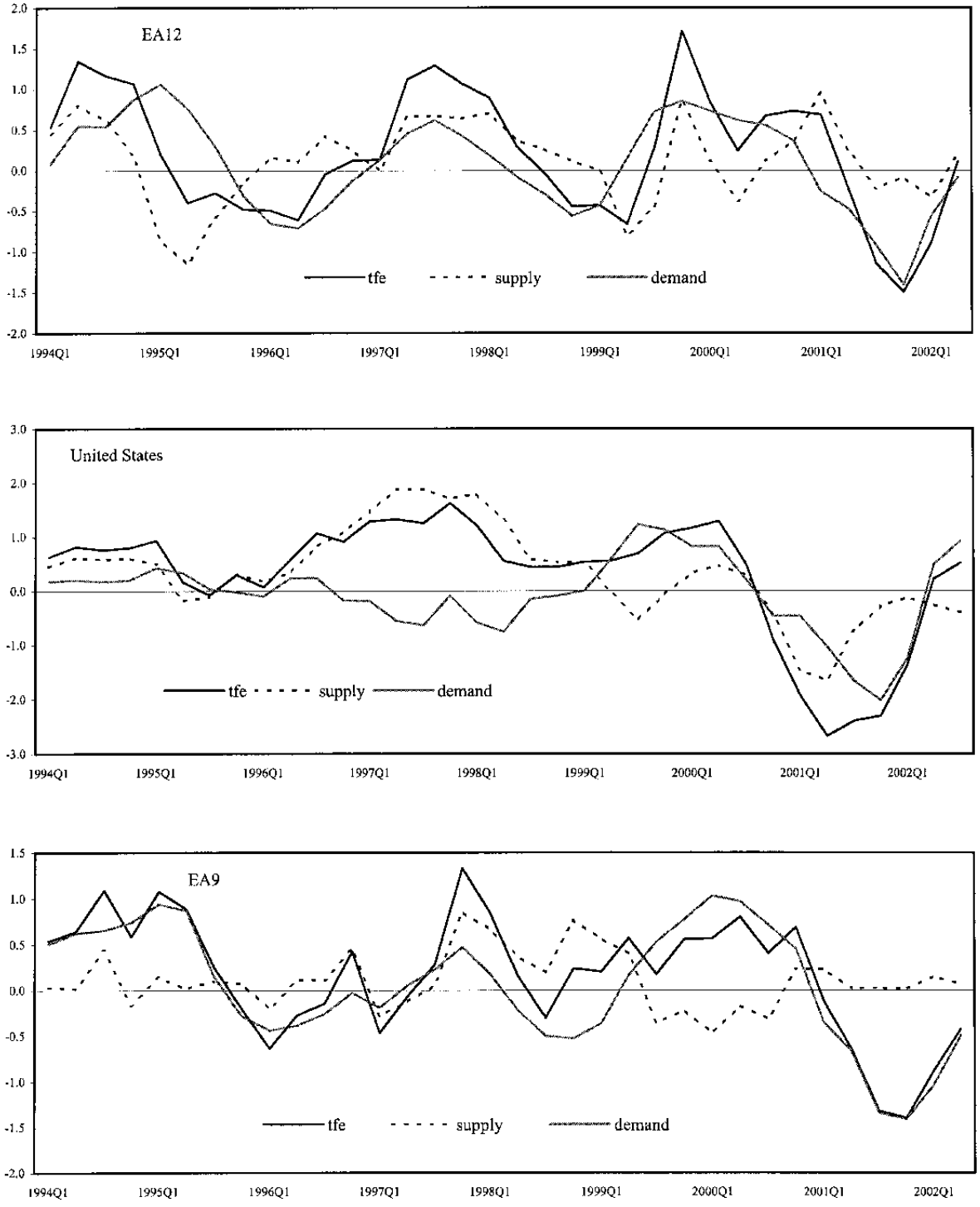
26. Would the use of the real GDP and GDP deflator pair change the analysis? Figure 8 indicates that the use of these series would place more weight on a mix of both demand and supply innovations in determining forecast errors. For the euro area, demand innovations first

Figure 6. Decomposition of Output Total Forecast Error 1/
(Industrial Production and Producer Prices: 1963:1 to 2002:3)



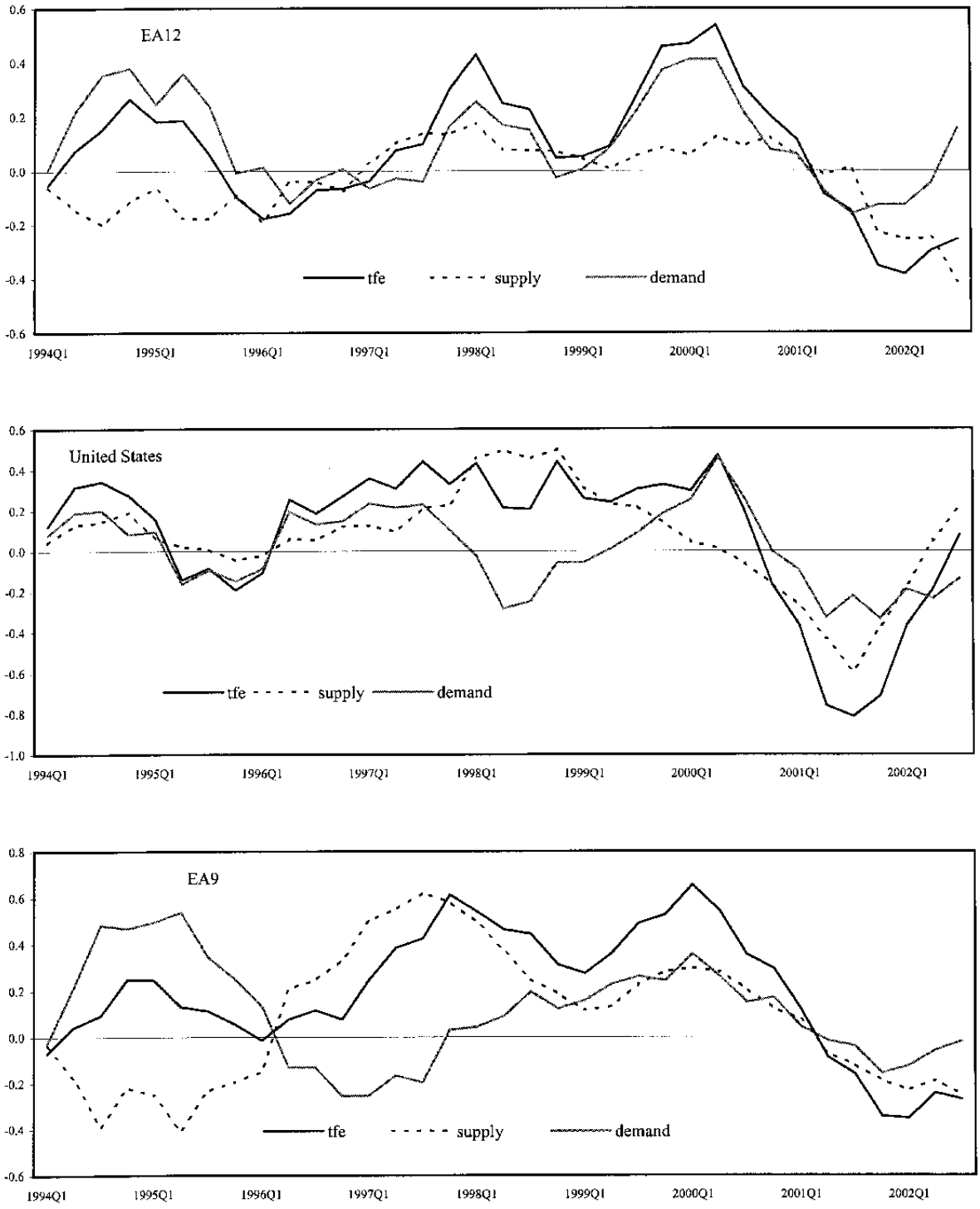
Source: Staff estimates.
1/ Total forecast errors are based on an 4-quarter ahead forecast. To reduced the volatility of the figures, a two quarter average of the components are shown. The summation of supply and demand components equal the total forecast error.

Figure 7. Decomposition of Output Total Forecast Error 1/
(Industrial Production and Producer Prices: 1980:1 to 2002:3)



Source: Staff estimates.
1/ Total forecast errors are based on an 4-quarter ahead forecast. To reduced the volatility of the figures, a two quarter average of the components are shown. The summation of supply and demand components equal the total forecast error.

Figure 8. Decomposition of Output Total Forecast Error 1/
(RGDP and GDP Deflator: 1980:1 to 2002:3)



Source: Staff estimates.
1/ Total forecast errors are based on an 4-quarter ahead forecast. To reduced the volatility of the figures, a two quarter average of the components are shown. The summation of supply and demand components equal the total forecast error.

turn sharply downward in mid-2000, with supply shocks moving markedly downward about a year later. Moreover, negative supply shocks continued to impact output at the end of 2002. For the United States, the results also indicates that a mix of negative supply and demand factors was at work in downswing. But, in contrast to the euro area, there is a sharp rebound in the supply shock component at the end of the sample period.

27. One troubling aspect of the total forecast error historical decompositions using industrial production is the appearance of positive supply shocks in the middle of the downturn. This may be due to the large swings in producer prices during this period. In essence, the identification procedure may have taken the downturn in producer prices or return to its mean as a signal of a positive supply shock. And since output was falling, demand innovations may have been erroneously identified as the main driving factor—or at least given it too much weight.

28. To try to avoid this problem, bivariate VAR decompositions were also estimated using industrial production and capacity utilization. Given the inherent stationarity of capacity utilization, its use would be more in line with the original implementation of the BQ methodology, which used the logged difference of U.S. output and the level of unemployment. Capacity utilization data are also often based on survey data, and therefore incorporates information on actual perceptions of economic slack in the economy. At the same time, the use of capacity utilization has drawbacks. First, long capacity utilization series are only available for the EA3 and the United States. Second, the impulse response function for positive supply shocks to capacity utilization tended to report an increase in utilization, perhaps suggesting problems with the identification restrictions.

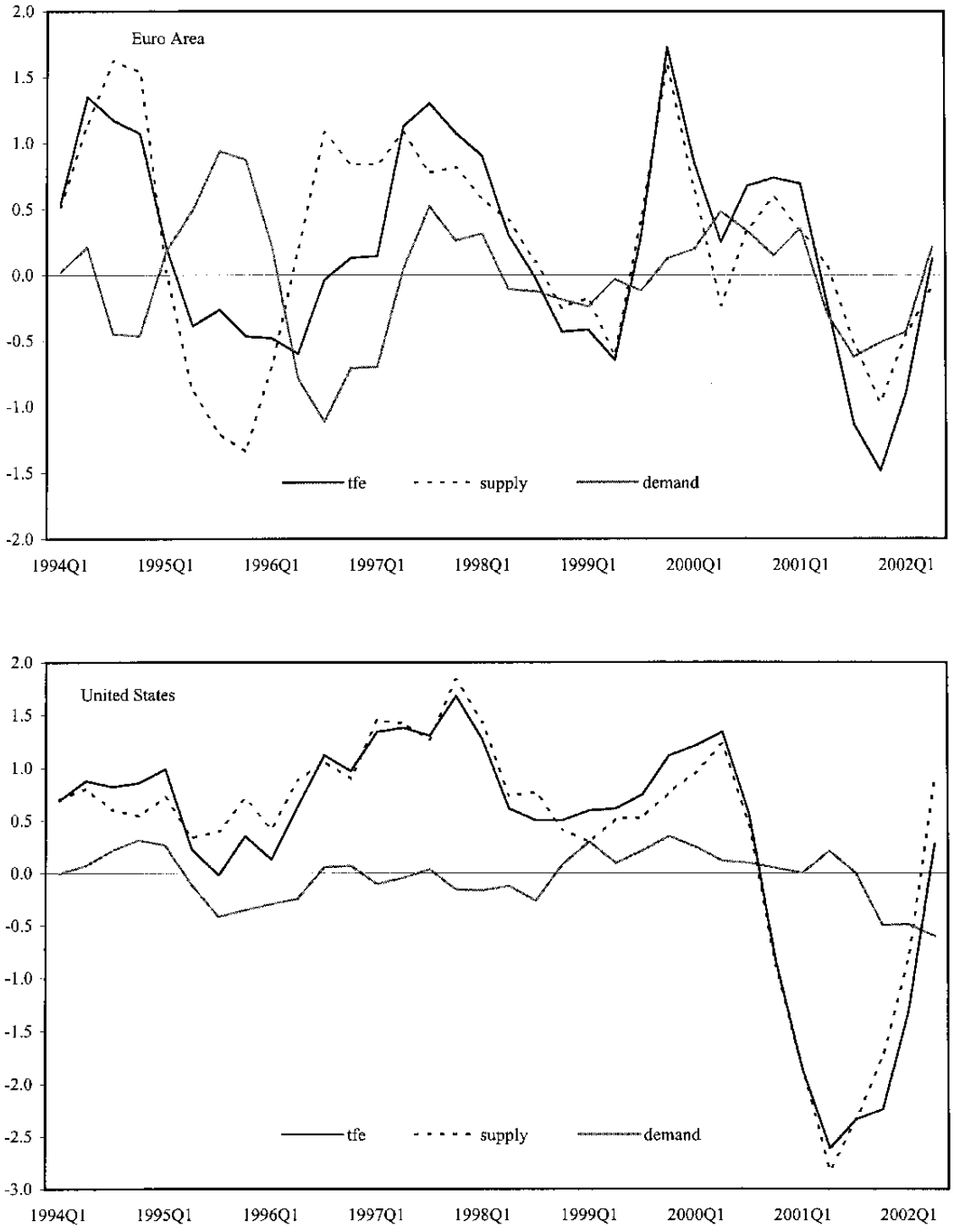
29. Figure 9 presents the historical decompositions of output forecast errors using industrial production and capacity utilization. For the euro area, this particular decomposition suggests some evidence of a short positive supply buildup in 1996-98 and attributes most of the 2000 output expansion to supply-side factors. In addition, the sharp slowdown in output starting in the second half of 2000 is attributed to a mixture of both supply and demand shocks. By comparison, the results for the United States place even more emphasis on supply side innovations, implying that the majority of the slowdown starting in 2000 in the United States can be linked to supply side factors.

F. Conclusions

30. The results of this empirical identification of the shocks that have hit the euro area provide the basis for some tentative conclusions:

- As to the question of which innovations—supply or demand—explain output fluctuations on average, the answer is very sensitive to the period examined and the data set used. Using a long sample, in the euro area demand innovations seem to dominate, on average, the explanation of output fluctuations at the short-to-medium horizon.

Figure 9. Decomposition of Output Total Forecast Error 1/
(Capacity Utilization and Producer Prices:1985:1 to 2002:3)



Source: Staff estimates.
1/ Total forecast errors are based on an 4-quarter ahead forecast. To reduced the volatility of the figures, a two quarter average of the components are shown. The summation of supply and demand components equal the total forecast error.

- If, however, one abstracts from the turbulent 60-70s period and focuses only on the 1980s-2002 period, supply side factors would appear to play a more dominate role in explaining output fluctuations (as defined by industrial production) on average. This is especially so in the euro area, which under the shorter sample period reports small demand side influences at the very short forecast horizon. However, the use of real GDP and the GDP deflator indicates that the euro area output fluctuations could be dominated by demand innovations even using a shorter sample period.

- The results of historical decompositions (using industrial production and producer prices) that attribute forecast errors in any one period to supply or demand innovations indicate that demand disturbances may have played the main role in driving the current downturn in the euro area and the United States. The fact that this result was found using both the long and short sample periods indicates some degree of robustness.

- The outcome of historical decompositions using real GDP and the GDP deflator indicates that demand factors played at least a substantial role in the current downturn in the euro area and in the United States. However, negative supply innovations also played a decisive role. Moreover, for the euro area, it appears these negative factors, particularly on the supply side, are still at work.

- Historical decompositions using industrial production and capacity utilization, by contrast, suggest that supply factors played a dominant role in the current downturn, both in the euro area and the United States. The apparent discrepancy in the results between the decompositions that use prices compared with the decompositions that use capacity utilization should be a subject for further research.

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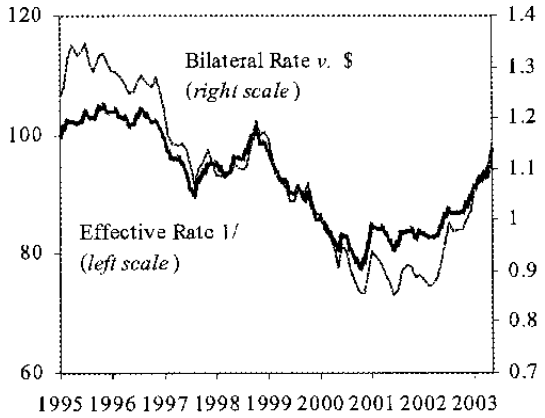
III. Exchange-Rate Pass-Through and External Adjustment in the Euro Area[1]

A. Introduction

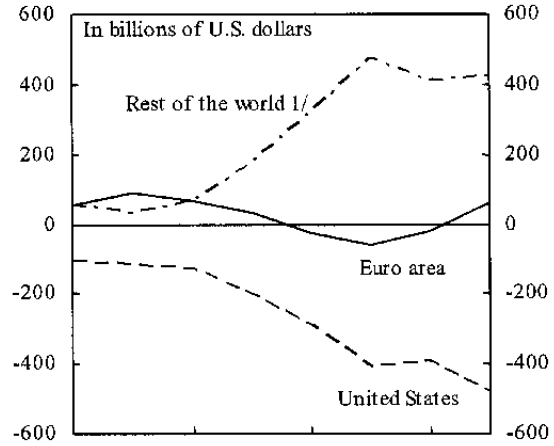
1. Recent swings in exchange rates and persistent external imbalances, particularly in the United States, have once again focused attention on the global alignment of currencies and current accounts. Over the past two years, the euro has appreciated by 30 percent against the dollar and by 20 percent in effective terms (see Figure 1). Currency movements notwithstanding, the constellation of current account positions among the major economies still shows considerable imbalances. Namely, the large U.S. current account deficit appears unsustainable from a long-term viewpoint and leaves open the possibility of a further significant decline in the value of the dollar.

Figure 1.
Euro Area Nominal Exchange Rates



1/ January 1995 = 100

Current Account Balances



1/ Including global current account discrepancy.

2. From the euro area's perspective, a possible global realignment along these lines is of central interest given its relative size in the world economy. In particular, with the prospect that the large U.S. deficit could eventually narrow substantially, the question remains as to what role currency and external adjustment in the euro area might play as part of that process.[2] Note that despite the depreciation of the euro over the period 1995-2001 the euro area current account was *not* the counterpart to the widening U.S. deficit (Figure 1).

3. In terms of area-wide growth and inflation, the extent to which exchange rate changes associated with external realignments will be passed through to domestic prices and the "expenditure-switching" effects that may result is also of clear interest and importance. A further disinflationary shock imparted by a strengthening euro, for example, could hamper the contribution of net external demand to the area's economic recovery in an environment where growth in consumption and investment spending are already weak.

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[1] Prepared by Hamid Faruqee.

[2] See Jaeger (2002).

4. The nature of external adjustment in the eurozone is a complex issue and likely depends on several factors. Some issues are fairly straightforward. The patterns of international trade and finance, for example, help determine the euro area's economic "exposure" to exchange rate movements against key currencies.[3] More difficult to assess, however, are the behavioral considerations that underlie the extent of exchange rate pass-through in prices as well as the responsiveness of trade flows to relative price signals. These issues are important in determining the strength of "expenditure-switching" effects from exchange rate movements.[4] Incomplete pass-through, for example, could delay or diminish the response in external variables and produce a certain degree of "exchange rate disconnect."[5]

5. Several economic explanations have been put forth to account for incomplete exchange rate pass-through—a feature that has strong empirical support for a larger number of economies, including the euro area.[6] With nominal rigidity and local currency pricing, destination prices can change very little in the face of exchange rate fluctuations.[7] With "pricing to market" behavior, segmented markets allow firms to stabilize their destination prices (via changing mark-ups) in response to fluctuating exchange rates to preserve foreign market share. In the presence of local distribution costs, firms may also face offsetting factors when the exchange rate changes, leading to international price discrimination and incomplete pass-through.[8] These factors can also help account for differential responses between first stage pass-through (e.g., in import prices) and second stage pass-through (e.g., in consumer prices).

6. This paper further examines exchange-rate pass through and external adjustment in the euro area. The methodology proceeds in two parts. First, the empirical analysis follows a vector autoregression (VAR) approach, where the time-series behavior of the euro exchange rate and a system of euro area prices are jointly examined. Specifically, the empirical analysis investigates exchange rate pass-through in a *set* of prices along the pricing chain.

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[3] Measurement of currency weights, however, may not be as straightforward. Issues such as indirect competition in third-country markets complicate these matters in practice. See Zanello & Desruelle (1997). The role of financial linkages and balance-sheet effects—e.g., the currency composition of debt—is another complicating factor. See Slavov (2002).

[4] See Obstfeld (2002) and Engel (2002) for a recent review of these issues.

[5] See Devereux and Engel (2002) and Krugman (1989).

[6] See Goldberg and Knetter (1997) for a survey. See Kieler (2001), Huffner and Schroder (2001), Anderton (2003), and Hahn (2003) for euro area estimates.

[7] See Betts and Devereux (1996, 2000) and Devereux and Engel (2002).

[8] See Corsetti and Dedola (2002) and Choudhri, Faruqee, and Hakura (2002).

Second, the impulse-response functions (IRFs) from the VAR estimates are used to help calibrate in a new open economy macroeconomics model those key behavioral parameters that underlie the pattern of exchange rate pass-through and external adjustment in the euro area. Repeating the exercise for the United States and the other major industrial countries, the framework can provide some insight into the likely pattern of external adjustment in a multilateral context.

7. The use of a VAR approach to examine exchange rate pass-through has several advantages compared to single-equation based methods. Previous studies typically focus on pass-through into a single price (e.g., import or consumer prices), without further distinguishing the types of underlying exchange rate shocks (e.g., permanent or transitory). By investigating exchange rate pass-through into a set of prices along the pricing chain, the VAR analysis characterizes not only absolute but *relative* pass-through in upstream and downstream prices. Second, the VAR methodology potentially allows one to identify specific "structural" shocks affecting the system. In this case, a structural exchange rate shock is identified through a Cholesky decomposition of innovations, where exchange rate fluctuations at higher frequencies are assumed to be largely driven by exogenous asset market disturbances.

8. Using this identification scheme, one can map the empirical results into a well-defined shock in an economic model of incomplete pass-through. Specifically, the estimated impulse-response functions from an exchange rate shock in the VAR are matched to the response patterns generated by the corresponding asset market disturbance in the pass-through model. Minimizing the distance between these sets of IRFs is used to identify key behavioral parameters that underlie the pattern of exchange rate pass-through. These parameters include the pricing behavior of firms (i.e., the extent of local currency pricing), the degree of nominal rigidity, and the extent of local distribution and trading costs generating international price discrimination.

9. Based on the empirical estimates, the analysis investigates the expected impact of the recent euro appreciation on area-wide prices and trade flows. Combined with the calibrated model, the scenario of a further decline in the value of the dollar and the resultant pattern of external adjustment is also examined. In particular, for a uniform decline in the dollar, the pattern of realignment in external positions between the euro area and the other major industrial economies is further analyzed.

B. Empirical Estimates

10. The empirical analysis focuses on euro area prices and the exchange rate at a monthly frequency. The time span covers the period from 1990 through 2002. All series are expressed in logarithms. For the euro exchange rate s, the nominal effective series is defined for the

ECB's "narrow" group of partner countries.[9] For factor prices or wage earnings *w*, the series derive from quarterly data on nominal compensation per employee, extrapolated to a monthly frequency.[10] For trade prices, import prices *pm* and export prices *px* are based on unit values in extra-area manufacturing trade.[11] Producer prices *py* are based on the producer price index for manufacturing, excluding construction and energy. Consumer prices *pc* are based on the core CPI—i.e., excluding energy and unprocessed foods—from the harmonized index of consumer prices (HICP).[12] The exclusion of energy prices is motivated by the standard finding that its pass-through behavior differs from that of other goods.[13]

11. The use of extra-area trade data helps avoid potential pitfalls from ascertaining pass-through for the euro area from estimates for individual member countries. To the extent that intra-area trade systematically differs from extra-area trade with respect to pass-through behavior, aggregating individual country estimates to generate an area-wide measure could suffer from a "fallacy of composition." Hufner and Schroder (2001), for example, construct pass-through estimates for euro area consumer prices by summing over individual country estimates, based on each country's weight in the area-wide HICP. The analysis is then required to make some "correction" of the estimates due to the presence of intra-area trade.

12. Before turning to the VAR estimation of euro area pass-through, some preliminary tests of the data were first conducted. Namely, unit root and stationarity tests indicate that these nominal variables are non-stationary in levels but stationary in first differences, suggesting that they are integrated of order one or $I(1)$ series.[14] Furthermore, residual-based cointegration tests do not find evidence of cointegration among the variables; see appendix.

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[9]Partners countries consist of the United States, Japan, Switzerland, the United Kingdom, Sweden, Denmark, Norway, Canada, Australia, Hong Kong, South Korea and Singapore.

[10] Price and wage data are from Eurostat and not seasonally adjusted. The area-wide measures reflect aggregates of the 11 participating countries through December 2000. Thereafter, the chained series include Greece as the 12th member country.

[11] Manufactured goods include Sections 5 to 8 of the Standard International Trade Classification (SITC).

[12]For the United States, Japan, United Kingdom and Canada, all corresponding monthly series were drawn from the IMF's *International Financial Statistics*, except wages which were obtained from the OECD's Analytical Database.

[13] See, for example, Campa and Goldberg (2001).

[14] The differenced series for euro area consumer and import prices were borderline non-stationary; see appendix. But as is well-known, unit root and stationarity tests have low power, making it difficult to distinguish between stationary and unit root processes in finite samples.

Given potential non-stationarity and lack of cointegration in the levels data, estimating the VAR in first differences is appropriate.

VAR methodology

13. The VAR approach examines the joint historical time-series behavior of the euro exchange rate and a system of euro area prices. Specifically, the reduced-form VAR(p) can be written a follows:

$$\begin{aligned} Y_t &= c + A(L)Y_{t-1} + \mu_t ; \\ \mathrm{E}[\mu_t \mu_t'] &= \Omega , \end{aligned} \tag{1}$$

where $Y = [\Delta s \ \Delta w \ \Delta pm \ \Delta px \ \Delta py \ \Delta pc]'$, c is a vector of deterministic terms (i.e., monthly time dummies), A is a matrix polynomial of degree of p in the lag operator L, and μ is the (6x1) vector of reduced-form residuals with variance-covariance matrix Ω. The exchange rate is placed first in the order of variables, reflecting the presumption that exchange rate innovations at monthly frequency are primarily driven by exogenous asset market disturbances.[15] For prices, the ordering after the exchange rate is motivated by the pricing chain, from factor input prices to trade prices to wholesale producer prices and retail consumer prices. The ordering among price variables after the exchange rate does not matter for the subsequent analysis of the exchange rate shock.

14. To recover the underlying exchange rate shock, the Cholesky decomposition of the matrix Ω is used to produce orthogonalized innovations ε. These disturbance terms are expressed in terms of the reduced-form VAR innovations as follows:

$$C\varepsilon_t = \mu_t , \tag{2}$$

where C is the unique lower triangular Cholesky matrix with 1s along its principal diagonal.[16] Because the exchange rate appears first in the VAR, the recursive structure in (2) imposes the assumption that orthogonalized innovations to the exchange rate depend only on the residuals from the exchange rate equation and not the other variables. This identification thus allows for a simple correspondence between the VAR estimates and a well-defined

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[15] The identification scheme largely follows Choudhri, Faruqee, and Hakura (2002). That analysis also includes the interest rate in the VAR in order to further distinguish between the effects of interest rate and exchange rate shocks on prices. McCarthy (2001) and Hahn (2003) also uses a Cholesky decomposition to examine pass-through based on a somewhat different model.

[16] The symmetric positive definite matrix Ω can be decomposed into unique lower triangular and diagonal matrices such that $\Omega = CDC'$. Using equation (2), this decomposition then produces innovation terms that are uncorrelated by construction—i.e., $\mathrm{E}[\varepsilon_t \varepsilon_t'] = D$.

shock in the model described later. For prices, the corresponding disturbance term will represent a mix of shocks, including the structural exchange rate shock.[17]

15. An alternative identification scheme would place the exchange rate last (or near last) in the VAR. This ordering is motivated by the view that prices (and quantities) are *predetermined* in the very short run and, thus, cannot respond to an exchange rate shock, whereas the exchange rate can respond to various shocks.[18] While this restriction may indeed be valid for many prices, it may not be appropriate for others. More to point, this ordering *imposes* a specific pass-through pattern in the estimates, and, ultimately, certain behavioral features in the model, that the current analysis seeks to investigate.

16. The implications of the present identifying restriction can be further understood from the structural representation of the VAR:

$$F(L)Y_t = k + \varepsilon_t \ , \tag{3}$$

where $F(L)$ is a matrix polynomial of degree $p+1$, k is a transformation of deterministic terms (i.e., $Ck = c$), and ε is the vector of structural shocks. One can show that the identification scheme based on the Cholesky decomposition introduces the following restriction: in the first equation—i.e., for the exchange rate Δs, the coefficients on contemporaneous price changes Δw, Δpm, Δpx, Δpy, and Δpc are equal to zero.

17. The economic justification for this identifying assumption can be understood as follows. Exchange rates, particularly at high frequencies, are essentially driven by asset market rather than goods market disturbances. From the asset market view of exchange rate determination, the prevailing exchange rate as a forward-looking price should reflect not only current but expected future economic conditions affecting the supply and demand for foreign exchange. Changes in the exchange rate can then be expressed in terms of a predictable component (usually deemed to be small) and a potentially large unexpected component, reflecting the impact of new information on expectations of all future economic conditions.[19] Short-run changes in the exchange rate, consequently, are likely to be dominated by "news" and not be predictable based on lagged price data.[20] The VAR identification scheme takes

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[17] For the first variable—i.e., the exchange rate, the orthogonalized disturbance term is given by $\varepsilon_{1t} = \mu_{1t}$. For the jth variable ($j > 1$) in the VAR, the corresponding shock term is given by $\varepsilon_{jt} = \mu_{jt} - c_{j,1}\varepsilon_{jt} \ldots - c_{j,j-1}\varepsilon_{jt}$, where $c_{j,i}$ correspond to the entries of the Cholesky matrix; See Hamilton (1994).

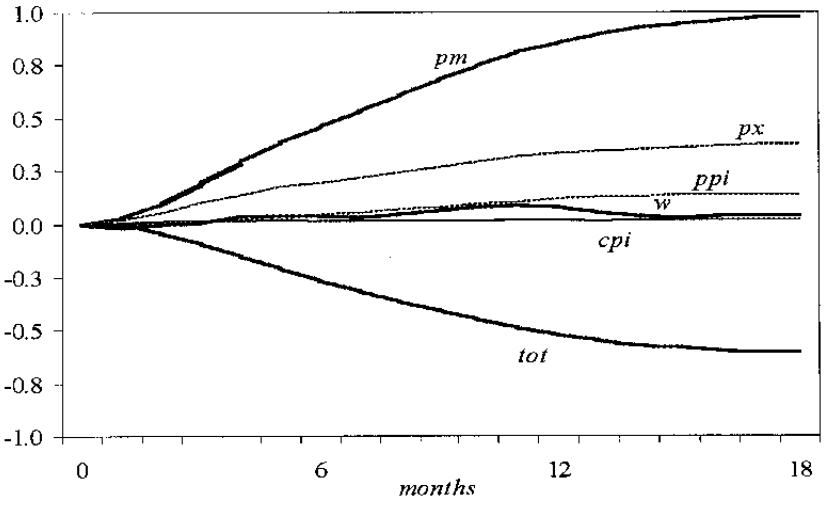
[18] See, for example, Peersman and Smets (2001).

[19] See Mussa (1984).

this view one step further, specifying that contemporaneous price innovations also do not help explain exchange rate innovations.[21]

18. Based on the reduced-form estimates of the VAR and the Cholesky decomposition to identify structural shocks, accumulated impulse-response functions to a unit structural exchange rate shock are shown in Figure 2.[22] The horizontal axis measures the time horizon in terms of months after the shock; the vertical axis measures the percent deviation in prices from their baseline levels.

Figure 2. Effects of an Exchange Rate Shock on Euro Area Prices
(unit structural shock; estimation period: 1990-2002)



19. Figure 2 shows that the short-run effects of an exchange rate shock on prices are very small in the euro area. Prices tend to be predetermined or very sticky (in local currency)

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[20]Granger causality and block exogeneity tests find that (lagged) euro area prices have no predictive value for the euro exchange rate. The exchange rate, however, helps predict (at least) trade prices. See appendix. Restricted VAR estimates (not reported) excluding lagged prices from the exchange rate equation yield very similar results to those reported in the paper.

[21] Reporting lags in prices may be one motivating factor. The presence of noise traders may be another consideration. See, for example, Jeanne and Rose (2002) and Devereux and Engel (2002).

[22] Given the large number of parameters in the VAR, a parsimonious lag structure is sought to conserve degrees of freedom. The lag length p is chosen by starting with given maximum lag length and sequentially testing the incremental significance of dropping an additional lag based on the likelihood ratio test.

initially in response to a unit depreciation in the euro effective exchange rate. Over time, the degree of exchange rate pass-through generally tends to rise, although the extent in factor and retail prices remains comparatively small. Wholesale producer prices tend to rise more than retail consumer prices, but the greatest response is in trade prices. A year to 18 months after the shock, export prices respond by almost half the response in import prices, which moves in proportion to the unit exchange rate shock, suggesting full pass-through. Consequently, the manufacturing terms of trade (*tot*) for the euro area tends to worsen or decline in response to an exchange rate depreciation.[23]

20. Normalizing the price responses in Figure 2 by the exchange rate response, Table 1 summarizes the time paths for pass-through elasticities in euro area prices. After 18 months, pass-through rates in export and import prices are about one-half and one, respectively. Wage pass-through is relatively very small at 5 percent. Pass-through in wholesale prices is nearly 20 percent, significantly exceeding the pass-through in retail prices.[24] These results are robust to re-orderings of the VAR.[25] Using headline rather than core inflation (or including longer lags), would raise the degree of pass-through in consumer prices to near 10 percent at 18 months, but the pattern of relative pass-through remains intact.

Table 1. Euro-Area Pass-Through Elasticities
(Percent change in prices divided by percent change in exchange rate)

	$T = 1$	$t = 6$	$t = 12$	$t = 18$
Cpi	0.00	0.01	0.02	0.02
Ppi	0.00	0.04	0.11	0.17
Wage	-0.02	0.04	0.07	0.05
Px	0.02	0.18	0.31	0.45
Pm	0.03	0.42	0.81	1.17

Notes: Based on impulse-response functions from 6-variable VAR estimated on monthly data from 1990 through 2002.

[23] Obstfeld and Rogoff (2000a) provide extensive evidence that the terms of trade declines with a currency depreciation—an observation that appears at odds with the implications of strict LCP models. See also Lane (2001) for a review.

[24] Gagnon and Ihrig (2002) find very low degrees of pass-through in consumer prices for twenty industrial countries and argue that pass-through has been declining. Their average estimate for long-run CPI pass-through is around 5 percent.

[25] As shown in the appendix, placing the exchange rate *last* among the variables does not materially alter the pass-through effects in the specific case of the euro area. With the exchange rate last, the initial or impact effects on prices are restricted to be exactly zero, but that is closely in line with the "unrestricted" estimates shown in the table. The interpretation of the exchange rate shock, however, becomes more difficult in this case as it incorporates a mix of innovation terms from all the price equations.

21. Full pass-through in euro area import prices over time may be a somewhat surprising result.[26] Alternative specifications—e.g., with coefficient restrictions or VAR re-orderings—tend to yield smaller but still high pass-through elasticities between 0.7 and 1. In a recent paper that also examines extra-area manufacturing trade prices, Anderton (2003) also finds generally high (albeit not full) pass-through between 0.5 to 0.7, based on a single equation approach.[27] Given the identification of near-permanent exchange rate shocks from the VAR estimates here, it is not surprising that import price pass-through in this analysis lies somewhat above those single-equation based estimates.

Cross-country evidence

22. Before relating the empirical findings to the theoretical model, it is useful to compare the pass-through results for the euro area to the other major industrial economies. Repeating the VAR exercise for the United States, Japan, United Kingdom, and Canada produces the pass-through coefficients for trade prices shown in Table 2.

23. As evident from the table, pass-through is incomplete, particularly in the short run. For the United States, pass-through in trade prices at the time of the shock is near zero, quite similar to the response of euro area. But while pass-through rises significantly over time in the euro area, the extent of the increase is much smaller for the United States. For the other countries, pass-through to import and export prices are higher on impact than for the U.S. and the euro area. For Canada and Japan, import prices pass-through estimates are about 60 to 70 percent initially and remain around those levels over time; for the United Kingdom import price pass-through eventually reaches 60 percent, but is initially half that. Pass-through in export prices is (eventually) around 50 percent for these three countries, similar to the euro area.

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[26] These estimates should be taken as indicative, given the standard errors of the impulse-response functions. Based on boot-strapped standard errors, the 90 percent confidence interval for import prices is the widest, suggesting pass-through at 18 months in the range (0.6,1.4). The median value of this band suggest a slightly lower degree of import price pass-through (i.e., 0.95 at 18 months); otherwise, the median and estimated impulse-responses responses closely coincide.

[27] The time pattern is similar, though, with most of the price adjustment transpiring by 5 quarters. Based on a quarterly VAR, Hahn (2003) reports similar findings on the degree and time-pattern of pass-through in the euro area non-oil import deflator.

Table 2. Pass-Through Elasticities in Trade Prices: International Comparisons

	$t = 1$	$t = 6$	$t = 12$	$t = 18$
		Import Prices		
Euro Area	0.03	0.42	0.81	1.17
United States	0.06	0.15	0.18	0.30
Japan	0.61	0.56	0.57	0.57
United Kingdom	0.28	0.58	0.57	0.60
Canada	0.68	0.54	0.62	0.68
		Export Prices		
Euro Area	0.02	0.18	0.31	0.45
United States	0.00	0.00	0.06	0.12
Japan	0.62	0.50	0.48	0.47
United Kingdom	0.16	0.47	0.46	0.50
Canada	0.35	0.19	0.35	0.44

Notes: Based on impulse-response functions from 6-variable VAR estimated from 1990 through 2002. For Euro area, import and export prices based on unit values in manufacturing trade. For others, import and export prices based on unit values in total trade.

C. Model of Incomplete Pass-through

24. This section briefly describes the analytical framework used to interpret the VAR evidence in terms of underlying economic behavior. The stylized model generates incomplete pass-through based on many of the common themes found in the "new open economy macroeconomics" (NOEM) paradigm, following the seminal work of Obstfeld and Rogoff (1995).[28] A detailed derivation of the micro-founded model employed here can be found in Choudhri, Faruqee, and Hakura (2002). A descriptive summary of the model is as follows.

25. Imperfect competition characterizes the production and allocation of two differentiated goods—a traded intermediate good and a non-traded final (consumption) good. One differentiated primary factor (labor) enters the production of traded goods. A domestic retail sector also relying on labor services is then needed to transform intermediate goods into final consumption goods in each country. This structure gives rise to a pricing chain with five price indices: retail consumer prices, wholesale producer prices, import and export prices, and wages or factor prices.

26. Prices and wages are not fully flexible. Instead, prices and wages are updated only infrequently based on Calvo-type adjustment.[29] Specifically, the probability that a firm will

[28] See Lane (2001) for a survey of this literature.

[29] See Calvo (1983). See Kollman (2001) for a NOEM analysis with sticky wages and prices but without distribution costs.

revise its price in a given period is fixed equal to π. Correspondingly, the average interval over which prices remain fixed is $(1-\pi)/\pi$.[30] This framework generates staggered price setting behavior in the economy.

27. With nominal rigidity in an open economy, the question arises as to whether prices are sticky in terms of domestic or foreign currency. The two cases are referred to as local currency pricing (LCP), where prices are rigid in term of the destination or buyer's currency, and producer currency pricing (PCP), where prices are rigid in terms of the originating or seller's currency. Both types of pricing behavior are allowed for in the model. Specifically, the parameter ϕ and ϕ^* denote the share of domestic and foreign firms following producer currency pricing behavior. If $\phi = 1$, all domestic firms engage in PCP; If $\phi = 0$, all domestic firms engage in LCP.

28. Finally, segmented goods markets allow firms to price discriminate internationally. Following Corsetti and Dedola (2002), firms face trading or distribution costs in the export market, providing an incentive for 'pricing to market' (PTM) given their ability to do so.[31] Specifically, imports are assumed to go through local distribution channels before they can be used in the production of either intermediate or final goods. To sell one unit in the export market requires δ units of local labor services.[32] With this dependence on local currency wages, changes in the exchange rate lead to incomplete pass-through in trade prices and "pricing to market" behavior described by Krugman (1987) through a cost or supply mechanism.[33] The introduction of "pricing to market" along these lines helps limit the effects of import price pass-through on retail prices and helps generate greater overall persistence in the degree of incomplete pass-through over time.

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[30] Choudhri, Faruqee, and Hakura (2002) also examine the cases of wage and/or price flexibility in the model (i.e., $\pi = 1$) and find that these model variants generally fall short in explaining the estimated IRFs.

[31] Investigating extra-area import prices, Anderton (2003) finds that foreign suppliers attach a significant weight on the PTM strategy in efforts to maintain market share. Herzberg, et al (2003) find PTM to be the dominant consideration for U.K. import prices. Kieler (2001) provides comparative estimates for several industrial countries.

[32] Burstein, Neves and Rebelo (2001) find that distribution costs account for roughly 40 percent of final consumer prices in the United States. For comparison purposes in what follows, the distribution cost parameter δ is recast in similar units.

[33] See also Kasa (1992), Faruqee (1995) for analyses that introduce market-specific costs as a way to generate incomplete pass-through and pricing-to-market behavior. An alternative approach that focuses more directly on the demand mechanism through translog (i.e., non-CES) preferences can be found in Bergin and Feenstra (1999).

29. Benchmark parameters in the model follow the calibration in Choudhri, Faruqee and Hakura (2002) which are generally based on average estimated values for the major industrial countries—including euro area members Germany, France and Italy.[34] Monetary policy, for example, is specified by an interest rate rule targeting expected inflation in consumer prices and allowing for interest rate smoothing, with the corresponding parameter weights based on the average estimates for the (non-U.S.) G-7 countries.

30. To match the empirical impulse-response patterns, an asset market shock ξ to uncovered interest rate parity (UIP) in the model is considered. The scale and persistence of ξ is calibrated to reproduce the VAR's accumulated impulse-response path for the exchange rate from a structural exchange rate shock ε_s.[35] Simulating the model's price responses to the UIP shock then generates the analytical impulse-response functions. To find the "optimal" structural parameter values in the model consistent with the empirical evidence, the following loss function is minimized:[36]

$$\min_{\{\theta\}}\left[IR(P,\xi;\theta)-IR^{VAR}(P,\varepsilon_s)\right]'\left[IR(P,\xi;\theta)-IR^{VAR}(P,\varepsilon_s)\right] \tag{4}$$

where $IR(P,\xi;\theta)$ denotes the vector of simulated impulse-responses for the price vector P from an ξ shock in the model conditional on the set of structural parameters $\theta=\{\phi,\phi^*,\pi,\delta\}$.[37] $IR^{VAR}(P,\varepsilon_s)$ denotes the vector of accumulated impulse-responses to a structural exchange rate shock ε_s in the VAR. The time horizon for the impulse-response paths is 18 months.

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[34] The elasticity of labor supply was optimized in Choudhri, Faruqee, and Hakura (2002). In this analysis, it is preset in line with the optimal values previously obtained to replicate the low degree of wage pass-through evident in the data.

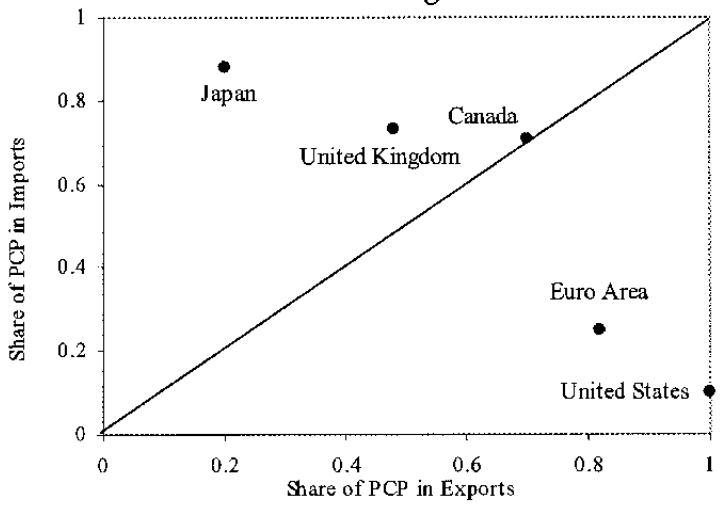
[35] The exchange rate shocks from the VAR have permanent or highly persistent effects on the (log) level of the exchange rate. Consequently, the UIP shocks are permanent or highly persistent as well.

[36] The standard errors for the accumulated impulse-response trajectories are fairly similar, suggesting that minimizing the (unweighted) least squares should yield similar parameters as the weighted least squares calculation following Smets and Wouters (2002). The weighted approach would give less weight to import prices in favor of consumer prices.

[37] The elasticity of substitution σ between traded goods was also chosen to minimize the distance between IRFs and found to be fairly low ($\sigma = 2$), in line with Smets and Wouters (2002) and the references cited therein.

31. Figure 3 displays the combinations of LCP and PCP behavior in domestic and foreign firms that best replicate the price responses--particularly, for trade prices--derived from the VAR estimates for each of the major industrial economies. The vertical axis measures the extent of PCP behavior ϕ^* in foreign firms (i.e., producing home imports) and the horizontal axis measures the extent of PCP behavior ϕ in domestic firms (i.e., producing home exports).

Figure 3. Pricing Behavior of Domestic and Foreign Firms



32. In the figure, the origin represents local currency pricing at home and abroad, while the opposing corner represents the case of universal producer currency pricing. The 45-degree line connecting them reflects symmetric combinations of local and producer currency pricing. In terms of symmetric outcomes, the mid-point along the 45-degree line tends to outperform either extreme empirically as shown by Choudhri, Faruqee and Hakura (2002). The intuition is as follows. Exclusive reliance on LCP behavior in both countries produces stable import prices at the destination which generally squares well with the data at the expense of unstable export prices at the point of origin which does not. The reverse is true in the case of PCP. As is evident from the VAR results in Table 2, *both* export and import prices in a given currency show incomplete pass-through. Consequently, a mix of the two behaviors fares better.

33. Figure 3 indicates, though, that the opposing diagonal is more relevant empirically in describing the pricing behavior of traded goods in an international setting. Specifically, *asymmetric* pricing behavior between domestic and foreign firms appears more consistent with the data. Allowing for LCP to a greater degree in certain trade prices and PCP to a greater extent in other trade prices tends to be more consistent than equal degrees of each. Specifically, the smaller, more open economies and Japan gravitate toward pricing in foreign currencies—i.e., LCP in exports and PCP in imports, while the larger, more insular economies of the United States and the euro area gravitate toward pricing in domestic currencies—i.e., LCP in imports and PCP in exports. As further supporting evidence, the

implicit currency pricing behavior suggested by Figure 3 appear very consistent with the data on invoice currencies for these countries.[38]

34. For the United Kingdom, pricing behavior is consistent with an "outward orientation." Domestic firms exporting to foreign markets tend toward LCP and set and stabilize prices in terms of foreign or destination currencies, safeguarding export market share. Import prices also tend to be rigid in terms of foreign currencies, as foreign exporting firms are less sensitive to fluctuations in their destination currency prices. Canada is similar to the United Kingdom with foreign currencies playing a large role in price-setting behavior of traded goods, albeit closer to the symmetric or equal weighting case.

35. Despite its relative economic size, Japan also exhibits considerable outward orientation. From Table 2, recall that both Japanese import and export prices show considerable pass-through on impact akin to the smaller, more open economies considered here. These results suggest that Japanese exporting firms predominantly engage in local currency pricing, while foreign firms largely engage in producer currency pricing. This finding accords with the conventional wisdom regarding the behavior of Japanese and foreign (predominantly U.S.) exporting firms described in Giovannini (1988), Marston (1990) and others.[39]

36. For the larger, more insular economies excluding Japan, both domestic and foreign firms tend to price in the 'dominant' currency associated with the large economy. For foreign firms exporting to the United States and to the euro area, this translates into destination currency pricing in dollars and euros, respectively. For U.S. and eurozone firms exporting abroad, this translates into producer or domestic currency pricing. For the United States, this result is well-established.

37. The similarity between the United States and the euro area is somewhat striking. While it is generally accepted that U.S. firms exporting to the euro area (and elsewhere) primarily invoice in dollars and engage in dollar-currency pricing, less is known about the pricing behavior of euro-area firms.[40] The results here suggest that the euro area behaves in

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[38]Bekx (1998) reports the following 1995 percentages of import and export prices that are respectively invoiced in domestic currency: United States (81,92), Japan (23,36), United Kingdom (43,62), and Germany (52,75). Note that the percentages for Germany refer to deutschemarks rather than euro-area currencies.

[39] See Dominguez (1999) for a related discussion of the limited role of the yen as an international currency, particularly as an invoicing currency. In principle, the choice of invoice currency is distinct from the issues of local versus producer currency pricing, but these issues share considerable overlap in practice.

[40]With the advent of the euro, some have suggested that the international role of euro will expand. See Bekx (1998) and Devereux, Engel and Tille (1999).

some measure like the United States with respect to the predominant role of domestic currency pricing for international transactions. The finding is largely driven by the similar lack of pass-through on impact of U.S. and area-wide import and export prices shown in Table 2. The use of manufacturing trade prices for the euro area accentuates this similarity; although using total extra-area trade prices (which show higher pass-through) would only slightly alter the relative placements shown in Figure 3.

38. There are also some important differences worth highlighting between the United States and the euro area. Specifically, the dynamic response of prices suggests significantly higher pass-through (particularly in import prices) for the euro area over time. Interestingly, this translates into a higher estimate for the Calvo parameter π –i.e., reflecting greater nominal flexibility.[41] Imposing a similar π value would shift the euro area in Figure 3 toward the other countries and away from the United States in terms of the mix of LCP versus PCP firms, although it would remain more closely aligned with United States.

39. In all countries, exchange rate pass-through in consumer prices is significantly lower than in trade prices. In the model, this "wedge" between intermediate and final goods is represented by local distribution, marketing or trading costs. Consequently, implicit estimates of local distribution costs limiting the pass-through into final goods prices are fairly substantial. Distribution costs δ, measured as a share of the final goods price, are estimated at roughly 38 percent for the United States, 40 percent for the United Kingdom and Canada, 50 percent for the euro area, and 60 percent for Japan.[42] Estimates in Burstein, Neves and Rebelo (2001) suggest a 40 percent share for the United States.

D. Implications for Euro Area Adjustment

40. Based on the empirical estimates from the VAR, several inferences can be made regarding the likely effects of the recent appreciation of the euro. To the extent that recent currency movements have been led by asset market developments, the following inferences could be drawn:

- The immediate effects of the recent exchange rate appreciation on area-wide prices are likely to be quite small in the near term. In response to the 15 percent effective appreciation in the euro over the past 12 months, manufacturing import prices could decline over time in proportion to the euro's advance, and manufacturing export prices could decline by half that amount, ceteris paribus. Area-wide consumer prices

[41]The estimate for π equals 0.1 for the euro area, suggesting an average time interval of about 9 months between price changes. The π estimates suggest an average duration exceeding one year for the other countries.

[42] High estimates of implicit distribution costs in Japan may reflect aspects of its unique distribution system. See Flath (2003).

could decline by ½ percent and 1 percent in terms of the core and headline CPI, respectively.

- Assuming no further exchange rate movements, the dynamic response patterns suggest that the full effects of the recent currency appreciation on euro area trade prices should largely manifest by end-2004.

- In terms of the trade balance, the calibrated model generates trade elasticities around ½ for euro area export and import volumes.[43] Including pass-through or price effects, the model suggests that nominal exports will decline by 9-10 percent, while nominal imports will remain broadly unchanged (due to offsetting volume and price effects) next year in response to the euro's appreciation. This indicates a prospective deterioration in the euro area trade balance of around 1 percent of GDP.

41. Combined with the VAR estimates for the other major industrial economies, the analytical framework can shed some light on the implications of a multilateral dollar depreciation and the resultant pattern of external adjustment.[44] First, Table 3 show the currency weights on the U.S. dollar in each partner country's effective exchange rate basket, which shows some country variation. In particular, the weights for Japan and for the euro area are one-quarter, while the weight for Canada—the United States' largest trading partner—is more than twice that size.

Table 3. U.S. Dollar Weights
(In percent)

Euro Area	Japan	United Kingdom	Canada
25.1	27.1	15.5	56.2

Notes: Dollar weight for the euro area based on ECB calculations, derived from average trade in manufactures (1995-97) with double weighting on exports to account for "third market" effects. Other dollar weights based on IMF Information Notice System (INS) methodology; see Zanello & Desruelle (1997).

42. The experiment considered here is a uniform 20 percent decline in the nominal value of the dollar against all other currencies. To the extent that a further decline in the dollar is

[43] The classic Marshall-Lerner-Robinson condition requires that the sum of trade elasticities exceed unity for a depreciation to improve the trade balance under traditional pass-through assumptions (i.e., zero and full pass-through in export and import prices, respectively). For example, Isard et al (2001) use elasticity benchmarks of 0.7 and 0.9 for export and import volumes.

[44] Subsequent calculations are partial and should only be taken as illustrative as the model is a two-country or bilateral framework, whereas the question of a global external realignment is a inherently a multilateral issue.

led by asset market developments (e.g., changes in market sentiment), the model's simulated response to a shock to uncovered interest parity should broadly reflect the effects of this disturbance. Table 4 summarizes the impact of the dollar depreciation on the trade positions of the major industrial economies.

Table 4. Effects of a Dollar Depreciation
(Change in trade balance)

United States	Euro Area	Japan	United Kingdom	Canada
		(In $ billion)		
125	-30	-20	-10	-20
		(In percent of GDP)		
1.2	-0.4	-0.5	-0.6	-2.2

Notes: Effects after 6 months derived from calibrated model based on country VAR estimates. Effects reflect both pass-through and volume effects, as well as output effects from the exchange rate adjustment. Initial trade balance and GDP based on 2002 estimates.

43. In response to the dollar decline, the U.S. trade position improves by $125 billion or more than 1 percent of GDP. Forty percent of this adjustment (in dollar terms) is reflected in lower trade balances for the euro area and Japan, given their economic size and reflecting their dollar weights. The effects relative to GDP for the euro area and Japan are fairly modest though, given the relatively closed nature of these economies. Japan has larger expenditure-switching effects (i.e., more responsive nominal trade flows) partly offset by being a more closed economy than the euro area. Expenditure-switching effects (in percent of GDP) are also generally larger in the U.K. and Canada, but the effects are much larger in the Canadian case, reflecting the difference in the respective dollar weights. Overall, $80 billion of the $125 billion adjustment in the U.S. is accounted for by the other major industrial economies including the euro area, with another $45 billion required from the rest of the world (for a given global discrepancy in trade).

44. Alternative scenarios wherein the euro experienced a larger multilateral appreciation as a result of weakening market sentiment in the dollar would magnify the external impact on the euro area. To date, it is worth noting that the "dollar area" has been sizeable with respect to recent currency movements, limiting the effective decline in the dollar. A narrow decline in the dollar against the euro (but not other currencies) translates into a wider appreciation of the euro. A plausible scenario would have this pattern continue, with some currencies following the dollar down—either due to market concerns or policy actions. For example, nagging concerns over Japan's economic outlook and the value of its currency suggests that the degree of yen appreciation against the dollar could be mild. In that case, the potential impact on the euro area's external position would be much larger, as the dollar and the yen (and the currencies pegged to them) account for over half of the euro area's effective exchange rate basket. From the perspective of prevailing current account positions, however,

a narrow decline in the dollar and a broad advance in the euro would not be particularly helpful in realigning major external imbalances.

E. Conclusions

45. Incomplete exchange rate pass-through in prices is a well-documented empirical regularity for many economies, including the euro area. A better understanding of the economic behavior underlying limited pass-through is an important consideration for investigating the implications of currency fluctuations and the pattern of external adjustment. The analysis here has sought to examine pass-through in a set of euro area prices along the pricing chain by using a VAR approach to identify the effects of an exogenous exchange rate shock. Mapping the effects of this structural shock into an analytical framework helps identify behavioral features that could help account for the nature of incomplete pass-through in the euro area. On the basis of the analysis, the following broad conclusions can be drawn:

- Short-run pass-though is very low in the euro area for a wide range of prices. Similar to the United States, the impact effect of an exchange rate shock on factor and trade prices, and on wholesale and retail prices, is near zero.

- Pass-through tends to rise over time in the euro area, although the extent of wage and consumer price pass-through remains comparatively small. Pass-through in producer and export prices is somewhat higher, but the highest degree of pass-though (near unity) is in euro area import prices. The differences in relative pass-through in import prices and consumer prices, for example, suggest that the roles of the retail sector and local distribution costs are important for price determination.

- The pattern of pass-through in trade prices suggests a fair degree of asymmetry with respect to the pricing behavior of domestic and foreign firms operating in the eurozone (and the U.S.). Specifically, the impulse-response patterns suggest a high degree of local currency pricing in import prices and producer currency pricing in export prices. For the United States and the euro area, this suggests that firms are pricing in dollars and euros, respectively. For Japan and smaller, more open economies, the behavior of pass-through is more consistent with firms operating significantly in foreign currencies.

- Local currency pricing and "pricing to market" behavior notwithstanding, expenditure switching effects still operate in these economies, although short-run trade elasticities can be small. Nevertheless, an exchange rate depreciation improves the trade balance overall, once both volume and pass-through effects are factored in. Given its generally small effects on the trade balance, however, the exchange rate adjustment required to achieve a moderate degree of external adjustment may be substantial in the absence of adjustment in other variables.

- Illustrative calculations of a generalized dollar decline suggest modest external adjustment implications for the euro area, given the size of expenditure-switching effects, dollar exposure, and the degree of trade openness. Effects of a dollar decline can be significant, as the Canadian case suggests, in economies with more trade openness and pass-through, and closer ties to the U.S. economy. But if the dollar were to weaken narrowly against the euro—i.e., if the "dollar area" remained large, the external implications for the euro area could also be more significant with a broader euro appreciation. Given prevailing current account imbalances, however, an unwinding of the large U.S. deficit would be better facilitated by a broader decline in the dollar rather than a further multilateral appreciation of the euro.

Unit Root and Stationarity Tests

Test statistics based on Phillip-Perron's non-parametric unit root test and Kwiatowski, et al (KPSS) stationarity test are shown in Table 5. The alternative hypothesis with the Phillips-Perron test and the null hypothesis with the KPSS test is trend stationarity. The tests suggest that the levels (first-differences) of these variables are non-stationary (stationary). The borderline cases where the tests give conflicting answers are CPI inflation—where the tests reject a unit root and stationarity, respectively—and import price inflation—where tests fail to reject a unit root and stationarity, respectively.

Table 5. Unit Root and Stationarity Tests
(Euro Area monthly data, 1990-2002)

Variable	Phillips-Perron Z_t Test	KPSS η_τ Test	Order of Integration
Neer	-2.34	0.34**	I(1)
Δ Neer	-8.46**	0.07	I(0)
Cpi	-2.89	0.74**	I(1)
Δ Cpi	-10.87**	0.36**	I(0) or I(1)
Ppi	-1.66	0.32**	I(1)
Δ Ppi	-5.86**	0.09	I(0)
Px	-0.92	0.27**	I(1)
Δ Px	-3.29*	0.10	I(0)
Pm	-2.38	0.15**	I(1)
Δ Pm	-2.61	0.11	I(0) or I(1)
Wage	-2.46	0.63**	I(1)
Δ Wage	-6.56**	0.07	I(0)

An *(**) indicates significance at the 10 (5) percent level.
Phillips-Perron unit root test includes deterministic time trend under the alternative.
Kwiatowski, et al (1992) stationarity test includes deterministic time trend under the null.

Cointegration Tests

Given that the unit root and stationarity tests suggest that the log levels of the exchange rate and various price measures are non-stationary, cointegration tests are conducted to examine whether a linear combination of these variables is stationary. Table 6 reports the results of Phillips-Ouliaris residual-based test for cointegration with window size = 2. Other window sizes produce similar results. The tests fail to reject the null of no cointegration.

Table 6. Cointegration Tests
(Euro Area monthly data, 1990-2002)

No. of Regressors	$\hat{P}_z$ Test (demeaned)	$\hat{P}_z$ Test (demeaned & detrended)
n = 5	115.10	120.43
	(225.23)	(284.01)

Notes: Multivariate trace statistic based on Phillips & Ouliaris (1990); 10 percent critical value given in parentheses.

Granger Causality Tests

Granger causality tests were conducted to examine if (changes in) euro area exchange rates and prices have predictive content for each other. Simple bivariate tests indicate that the nominal effective exchange rate Granger-causes (i.e., helps predict) several price measures, but prices fail to Granger-cause exchange rates. The exchange rate is found to be a significant predictor for trade prices and has predictive content for wages at shorter lag length.

Table 7. Bivariate Granger Causality Tests
(Euro Area monthly data, 1990-2002)

Price Measure	Lags	H_0 : Exchange rate does not cause price measure	Lags	H_0 : Price measure does not cause exchange rate
Cpi	12	0.66	2	0.96
Ppi	14	0.99	2	0.87
Px	13	0.06	2	0.27
Pm	13	0.00	2	0.70
Wage[1]	14	0.54	2	0.47

Note: Reported numbers are *p*-values on the relevant exclusion restriction (*F*-test).
Lag length selection based on Akaike Information Criterion.
[1]At one lag, the exchange rate Granger-causes wages ($p = 0.04$).

Block Exogeneity Tests

To generalize Granger causality tests to a multivariate context, consider the following partitioned VAR(p) system:

$$\begin{aligned} \Delta s_t &= c_1 + \mathrm{A}_1 X_{1t} + \mathrm{A}_2 X_{2t} + \varepsilon_{1t} \\ \Delta P_t &= c_2 + \mathrm{B}_1 X_{1t} + \mathrm{B}_2 X_{2t} + \varepsilon_{2t} \end{aligned},$$

where c_1 and c_2 represent a constant term and monthly time dummies, P represents the (5x1) vector of price variables, X_1 and X_2 are (px1) and (5px1) vectors of lagged changes in

exchange rates and prices, respectively, with conformable matrices of autoregressive coefficients A_1, A_2, B_1 and B_2. Block exogeneity test results are shown in Table 8 below.

Table 8. Block Exogeneity Tests
(Euro Area monthly data, 1990-2002)

Lag Length	$H_0: A_2 = 0$	$H_0: B_1 = 0$
p = 7	32.42	50.48
	(0.59)	(0.04)

Notes: Test statistic is based on likelihood ratio test with degrees of freedom correction and is distributed as $\chi^2(5p)$. Significance levels given in parentheses.

Sensitivity Analysis

In general, when the residuals from the VAR do not display high cross correlations, the order of factorization makes little difference.[45] Otherwise, the results can be sensitive to the choice of ordering.

Changing the order of the exchange rate, however, can be shown to have little impact on the results. Placing the exchange rate last in the VAR, for example, leaves the impact of an exchange rate shock less permanent, as the innovation becomes a mix of shocks. Moreover, the exchange rate shock has no contemporaneous effect on any prices (i.e., prices are predetermined) by construction. However, the implied pass-through elasticities remain similar to the case where the exchange rate appears first in the VAR. See Table 9.

[45] From the variance-covariance matrix, the correlations between residuals are less than 0.2 with the notable exceptions of the exchange rate and trade prices and between trade prices themselves.

Table 9. Euro-Area Pass-Through Elasticities Across VAR Re-orderings

	$t = 1$	$t = 6$	$t = 12$	$t = 18$
		(Exchange Rate First in VAR)		
Cpi	0.00	0.01	0.02	0.02
Ppi	0.00	0.04	0.11	0.17
Wage	-0.02	0.04	0.07	0.05
Px	0.02	0.18	0.31	0.45
Pm	0.03	0.42	0.81	1.17
		(Exchange Rate Last in VAR)		
Cpi	0	0.02	0.02	0.03
Ppi	0	0.05	0.11	0.18
Wage	0	0.04	0.08	0.05
Px	0	0.10	0.20	0.30
Pm	0	0.30	0.63	0.97

Notes: Entries report percent change in price measure divided by percent change in exchange rate in response to unit exchange rate shock from Cholesky decomposition of innovations.

As seen in the table, the implied pass-through elasticities from the two VARs are fairly similar. On impact, euro area prices are essentially predetermined in response to the exchange rate shock. However, it should be stressed that this response is *imposed* in the second VAR, rather than estimated, based on the ordering of variables. In the case of the euro area (and the United States) this restriction appears valid, although for other industrial countries this generally not be the case for certain prices as shown by Table 2 in the text.

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IV. AGING AND THE SGP[1]

A. Introduction

1. **Europe's aging populations make tackling pension reform essential for preserving fiscal credibility.** It has been extensively documented that aging populations imply large medium- to longer-term fiscal imbalances in most EU countries.[2] Nevertheless, few member countries have settled on specific and credible strategies that lay out how the looming pension financing gaps are going to be closed. Quite apart from the obvious benefit of increasing old-age income security, putting forward a credible pension reform strategy should also have payoffs for fiscal policy conduct in the short run. First, such a strategy would assure financial markets that aging is unlikely to put long-run fiscal sustainability at risk.[3] And second, strong fiscal credibility in the long run provides policy flexibility in the short run.

2. **This chapter discusses possible synergies as well as tensions between pension reforms and the fiscal rules of the Stability and Growth Pact (SGP).** Present pension systems in most EU countries are dominated by large-sized public pension pillars, usually financed on a pay-as-you-go (PAYG) basis. By contrast, prefunded pension pillars in the private or public sectors play a subordinated role. The SGP puts limits on the general government deficit (3 percent of GDP) and the general government gross debt (60 percent of GDP). Different pension reform strategies will affect general government measures of fiscal deficits and debt differently. Three stylized pension reform strategies serve to illustrate this point:

- *Closing PAYG financing gaps* on a year-by-year basis through parametric reforms that boost pension revenue (through increases in pension contribution rates or by measures that increase the number of contributors) or cut pension spending (through benefit cuts or reductions in the number of pensioners). As a first approximation, this reform option can be viewed as "SGP-neutral" because observing strict PAYG financing should be neutral with respect to the general government balance.[4]

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[1] Prepared by Albert Jaeger.

[2] See the most recent demographic and fiscal projections by the EU's Economic Policy Committee (EPC) (2001) and the OECD (2001).

[3] Standard & Poor's (2002) discusses possible adverse consequences for sovereign debt ratings in Europe if no progress is made on pension reforms.

[4] An exception would be the use of additional budget transfers to plug financing gaps in the PAYG system.

- *Shifting to public prefunding* of pensions (à la U.S. old-age and survivors trust fund) would imply running surpluses in the public pension system, at least over the next two decades or so. Parametric reforms could be used to implement public prefunding. The public prefunding option can be interpreted as "SGP-friendly" because the surpluses in the public pension fund help improve the general government's balance.

- *Shifting to private prefunding* of pensions (à la Chile in the early 1980s), by contrast, would lead to deficits in the public pension system during the transition period as contributions are diverted to private pension accounts (assuming the diversion of contributions is not fully offset by parametric reforms). This reform strategy can be classified as "SGP-unfriendly" in the short run as the deficits in the public pension system would contribute negatively to the general government's fiscal position.

3. **The EU's agreed "umbrella strategy" for pension reforms stresses public prefunding and parametric reforms as the way to go.** A joint report by the Commission and ECOFIN (2001) has called for a three-pronged approach. First, member countries should run down public debt and use the resulting interest savings to make room for additional aging-related spending.[5] Second, labor market reforms should raise employment rates, with particular attention given to raising employment rates among older workers and women. And third, parametric pension reforms should limit pressure on pension spending and promote growth. This umbrella strategy provides little encouragement for shifting to private prefunding and is thus unlikely to create tensions with SGP rules.

4. **But, for reasons discussed further below, a move to a multipillar pension system that includes private prefunding as a key pillar is likely to be part of any effective pension reform package that will credibly address Europe's aging problem.** In line with this presumption, there have been several noteworthy recent trends that illustrate potential tensions between pension reforms favoring private prefunding and the SGP:

- At a theoretical level, Tabellini (2002) has argued that the SGP's fiscal limits as currently formulated stand in the way of welfare-improving shifts to private prefunding. Razin and Sadka (2002) discuss a model wherein the aging of the population shakes the confidence in the public PAYG system, triggering a shift to partial private prefunding. In their model, SGP-type limits on the fiscal deficit obstruct, however, this shift, and relaxing the SGP constraint facilitates the move to partial prefunding desired by the median voter.

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[5] Running down public debt and using the interest savings to pay for pensions may be viewed as a special case of shifting to public prefunding. This policy is equivalent to building up a pension reserve fund and (assuming the interest rates on public debt and the reserve fund are the same) use the reserve fund's interest revenue to pay for pensions. The key difference is that the running down of public debt could be brought about by fiscal measures that do not include parametric pension reforms.

- At the level of the SGP, the Commission's proposals for improving the functioning of the SGP (2002) suggest that the SGP's "... *'close to balance or in surplus' requirement could be interpreted to cater for the intertemporal budgetary impact of large structural reforms that raise employment or growth potential ... and/or which in the long term improve the underlying public finance position.*" Thus, this proposal seems to envisage some flexibility in interpreting the SGP's underlying fiscal norm requirement if increases in fiscal deficits reflect significant pension reforms.

- Finally, at the level of national income accounting (European System of Accounts (ESA) 1995 and System of National Accounts (SNA) 1993), the existence of pension schemes in current EU member and accession countries that combine compulsory private prefunding with government undertakings that insure at least partly against the risk of underperformance has raised the question whether these schemes should be classified as private or public sector schemes. Classifying this type of scheme as part of general government could defuse possible tensions between pension reform strategies that favor private prefunding and the SGP. On the other hand, existing national accounting rules would probably argue against this approach. A Eurostat Task Force on Pension Schemes is currently studying this and other issues related to the treatment of pension schemes in the national accounts.[6]

5. **The rest of the chapter is organized as follows.** As background, Section B provides "full aging pass-through" projections to illustrate the fiscal implications of population aging under the assumption that public pension system parameters remain unchanged during the projection period. Section C discusses the reform option of public prefunding, highlighting the SGP-friendly implications of prefunding but also pointing out several drawbacks of this reform approach. Section D argues that at least some cuts in future public pension benefits will likely be part of any parametric reform package that is effective in containing future fiscal imbalances and that reasons of political time-consistency would then argue for the early buildup of a compensating private pension pillar. Section E suggests that the fiscal transition costs to private prefunding are potentially large and could conflict with SGP requirements. At the same time, there seem to be no ready-made solutions to resolve a potential conflict, and solutions may have to be found on a case-by-case and on a trial-and-error basis. Section F highlights the need for better informing the public on the nature of the fiscal unsustainability problems inherent in population aging. Section G concludes.

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[6] Furthermore, an international forum recently established by the Fund is discussing the recording of pension as part of an on-going review of SNA 1993. See the contributions to the electronic discussion group (EDG) on "The Treatment of Pension Schemes in Macroeconomic Statistics" at http:/www.imf.org/external/np/sta/ueps/index.htm).

B. Sizing Up Europe's Aging Challenge: The Full Aging Pass-Through Benchmark

6. **The effect of aging on public finances is best illustrated by considering the special case of full aging pass-through to pension spending.** The extent to which aging affects public pension spending can be gauged by using the standard equation defining nominal public pension spending (P):

(1) $P = \beta WM,$

where β is the average pension replacement rate, W is the average nominal wage, and M is the number of pension recipients. Nominal output (GDP) can be written as:

(2) $GDP = \mu WN,$

where N is employment (contributors to pension system) an μ proxies the average mark up on labor cost. Dividing (1) by (2) yields:

(3) $(P/GDP) = (\beta/\mu)(M/N).$

Using the symbols POP_{old} and POP_{work} to denote elderly and working-age populations, respectively, equation (3) can be expanded to give a well-known decomposition:[7]

(4) $(P/GDP) = [(\beta/\mu)(M/POP_{old})(POP_{work}/N)](POP_{old}/POP_{work}).$

Assuming the mark up (μ) is constant in the long run, the ratio (β/μ) can be interpreted as a measure of the generosity of pensions. The ratio (M/POP_{old}) is a measure of the eligibility of elderly persons to receive pensions. The ratio (POP_{work}/N) is the inverse of the employment rate (assuming all employed persons are contributing to the public pension system). And (POP_{old}/POP_{work}) is the elderly dependency ratio. Full pass-through of population aging to pension spending can now be defined as holding the three ratios in brackets on the right-hand side of equation (4) constant and allowing only changes in the elderly dependency ratio to feed through to public pension spending-GDP ratio:

(5) $_{FP}(P/GDP)_{t+j} = (P/GDP)_t[1+(\Delta(POP_{old}/POP_{work})_{t,t+j}/(POP_{old}/POP_{work})_t)],\ j=1, ..., n.$

7. **Assuming full pass-through, aging would dramatically push up public pension spending in most EU countries.** Using the EPC's (2001) preferred definition of the elderly dependency ratio—the ratio of the population aged 55 and over as a percent of the population aged 15-54—Figure 1 plots public pension spending-GDP ratios for the case of full aging pass-through for the EU as a whole and for the four largest member countries during

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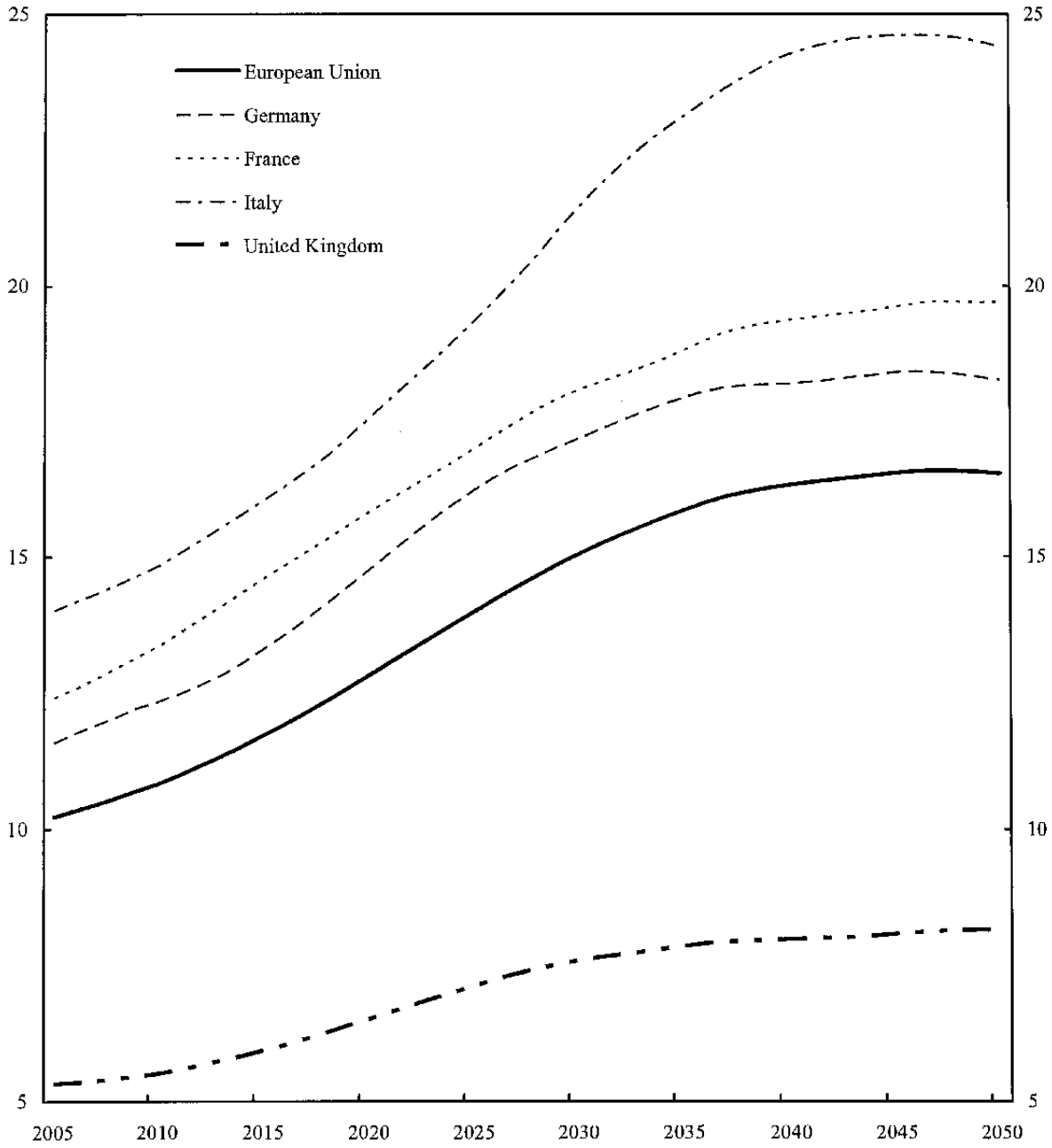
[7] EPC (2001) and OECD (2001) use this decomposition to illustrate the driving factors behind their projections.

Figure 1. Projected Public Pension Expenditures Assuming Full Aging Passthrough, 2005-2050
(In percent of GDP)



Source: EPC (2001); own estimates.

2005-2050.[8] From the paths of the pension spending-GDP ratios, it is obvious that aging populations hold the specter of large medium- to longer-term fiscal imbalance in the three largest countries, with Italy topping the aging cost league with almost one quarter of GDP projected to go to public pensions by 2050 if aging would be allowed to pass through fully to spending. Among the four largest EU member countries, the U.K. public pension scheme seems to be least vulnerable to aging, but this is largely a consequence of the relatively small size of the U.K. public scheme; aging itself in the U.K. is projected to be only marginally less pronounced than in France.[9]

8. Full aging pass-through benchmarks are also useful for bringing out implicit parametric reform assumptions in existing public pension spending projections. The benchmark of full-aging pass-through is also useful to assess implicit pass-through assumptions in conventional projections, such as the EPC's (2001) projections (Figure 2).[10] Projected aging pass-through seems to differ widely across the four largest countries: the projections for Germany and France assume relatively high pass-through, while in the case of Italy pass-through is fully eliminated by the end of the projection period. Most remarkable perhaps is the case of the U.K., which implies consistently negative pass-through.[11]

9. **Existing public pension spending projections seem to count mostly on future benefit cuts for closing pension financing gaps.** According to equation (4), low aging pass-through could reflect projected improvements in the labor market (more contributors to the pension system) or cuts in the generosity of the pension system. A breakdown into these two factors taken from EPC (2001) suggests that partial aging pass-through mostly reflects cutbacks in the generosity of public pension systems (Table 1). EPC (2001) also provides a further breakdown of the generosity component into an effect due to cuts in the generosity

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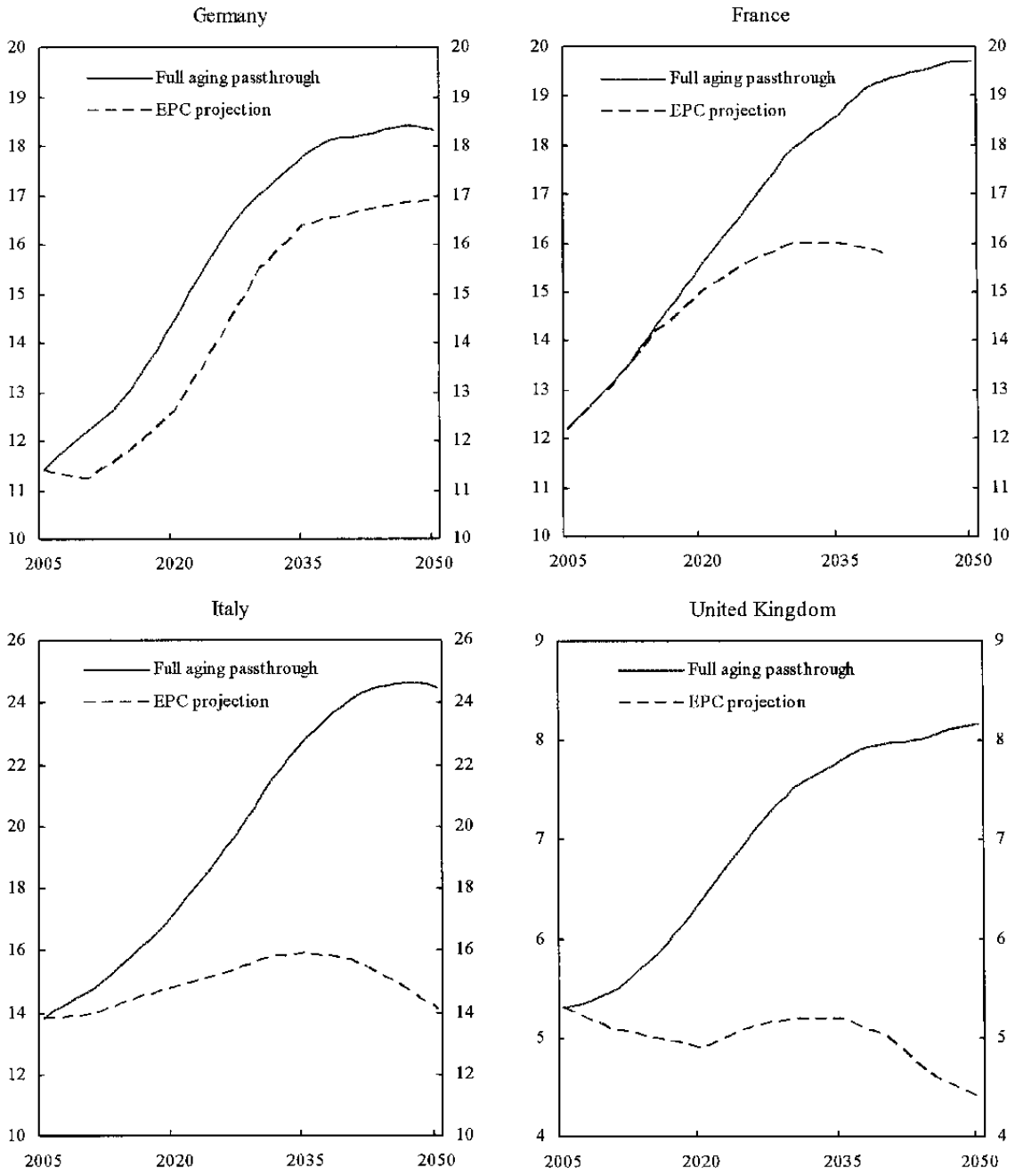
[8] The 2005 "starting value" for the pension-GDP ratio is taken from ECP (2001).

[9] The EPC study also tries to quantify the fiscal cost of aging for health care and long-term care of the elderly. These additional cost are not considered in this note, partly because estimates are more sketchy and tentative than for public pension outlays, and partly because adding them to pension costs simply re-inforces the points made here.

[10] EPC (2001) projections for public pension spending-GDP ratios during 2005-2050 (2005-040 for France) were only available at five-year intervals; the EPC projections for intervening years are based on linear interpolation.

[11] This mainly reflects the U.K.'s unusual indexation scheme: pension benefits for existing as well as new pensioners are indexed to prices, with the implication that the real value of the pension benefit remains constant over time and the average benefit replacement rate (β) in equation (1) would eventually converge toward zero with positive real wage growth in the long run.

Figure 2. Public Expenditure Projections: Full Aging Passthrough vs. EPC (2001), 2005-2050
(In percent of GDP)



Sources: EPC (2001); own estimates.

of pension benefits and an effect due to changes in eligibility (the share of pensioners in the elderly population). This more detailed calculation suggests that projected cuts in the generosity of pension benefits are mainly responsible for low aging pass-through.

Table 1. Sources of Low Aging Passthrough in EPC Projections of Pension Expenditure Increases During 2000-2050 1/

	Projected pension increase assuming full aging passthrough	Effects of:		Projected pension increase by EPC
		Labor market	Generosity of pensions	
Germany	6.4	-0.7	-0.7	5.0
France	7.6	-0.9	-2.7	4.0
Italy	10.1	-3.1	-6.7	0.3
U.K.	2.4	0.0	-3.5	-1.1
EU	6.4	-1.1	-1.5	3.8

Sources: OECD (2001) and EPC (2001); own estimates

1/ Percent of GDP.

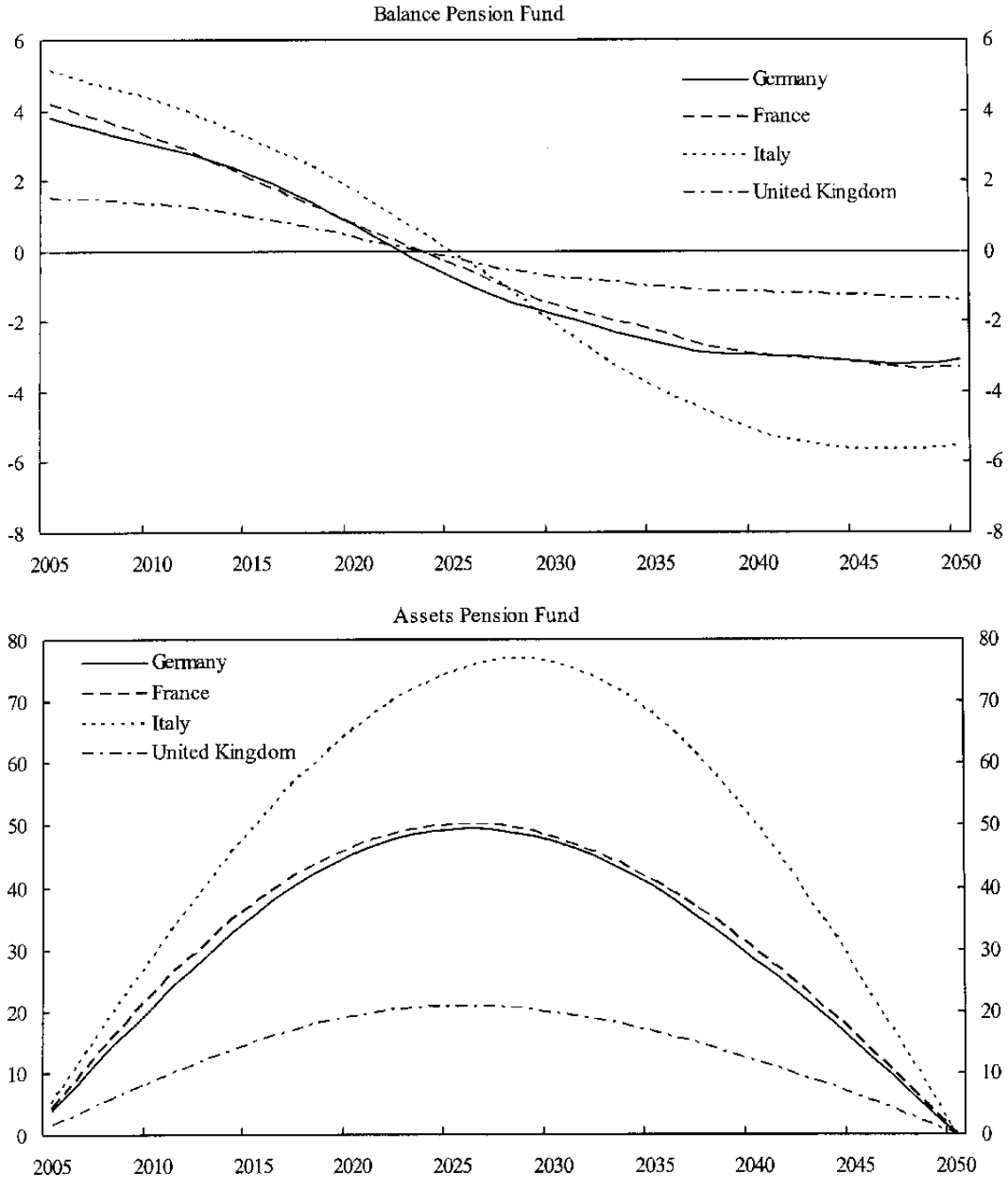
C. Prefunding the Public Pillar

10. **Public prefunding presents a key option for restoring fiscal credibility to public pension finances.** The public prefunding (or actuarial) balance approach establishes a pension reserve fund that serves as a buffer between an uneven public pension spending path and a relatively smooth pension fund contribution path. In the case of aging-related increases in public pension spending, an upward sloping spending path would first necessitate the accumulation of a pension reserve that can then be drawn down in later years when spending starts to exceed contributions. An example closely based on this principle is the U.S. Social Security Trust Fund for old-age and survivors insurance.

11. **Under public prefunding, most EU countries would need to build up large reserve funds.** The implication of the public prefunding approach for pension finances assuming full aging pass-through for the four largest EU countries is illustrated in Figure 3.[12]

[12] The details of the present value formulae needed for implementing the permanent balance approach are described in IMF (1996), Appendix I. The basic approach is to calculate the present discounted value of the constant pension contribution-GDP ratio that is equal to the present discounted value of the pension spending-GDP ratios in Figure 2. The assumed real interest rate in this paper is 3.5 percent; the projected path for real GDP growth is based on EPC (2001).

Figure 3. Permanent Balance Approach With Full Aging Passthrough, 2005-2050
(In percent of GDP)



Source: Own estimates.

In view of the upward sloping pension spending profiles in Figure 1, countries operating the permanent balance approach would first need to run surpluses over the next 15-20 years to accumulate a reserve fund that is then drawn down to meet higher pension spending due to aging pass-through. Reflecting their large-sized existing public pension systems, the initial pension fund surpluses in the cases of Italy, Germany, and France would have to be large, allowing the countries to accumulate a reserve fund that peaks at over 70 percent of GDP in the case of Italy and at over 40 percent of GDP in the cases of Germany and France. The implications of the permanent balance approach for general government finances are brought out in Figure 4.[13] The implied general government surplus for the next 15-20 years would amount to about 2 percent of GDP while debt-GDP ratios (net of pension fund assets) would decline drastically during this period. Thus, viewed from the context of the SGP, a stylized public prefunding strategy would at least over the next 15-20 years result in "close to balance or in surplus" norms with large safety margins relative to the 3 percent deficit limit.

12. **Public prefunding of pension systems could increase national savings and would address fiscal sustainability in a time-consistent way.** Public prefunding could have two advantages. (1) It could result in an increase of the national savings rate and an associated higher path of capital accumulation and hence output.[14] This consideration may be less of a concern for continental European countries, which generally have relatively high savings rates. (2) Public prefunding is likely to be a time-consistent reform strategy because once such a fund is accumulated it is likely to be difficult to find a majority of voters willing to dissolve a "pension trust fund."

13. **But public prefunding requirements are quite sensitive to the projection horizon (and other assumptions) and the pension fund's decumulation phase could clash with the requirements of the SGP.** Given their long-run nature, the projections of reserve fund balances and assets are particularly sensitive to the underlying assumptions. Figure 5 illustrates the case of Germany for horizons of 45, 70, and 145 years, respectively.[15] The further the projection horizon reaches out, the larger the required initial accumulation of a

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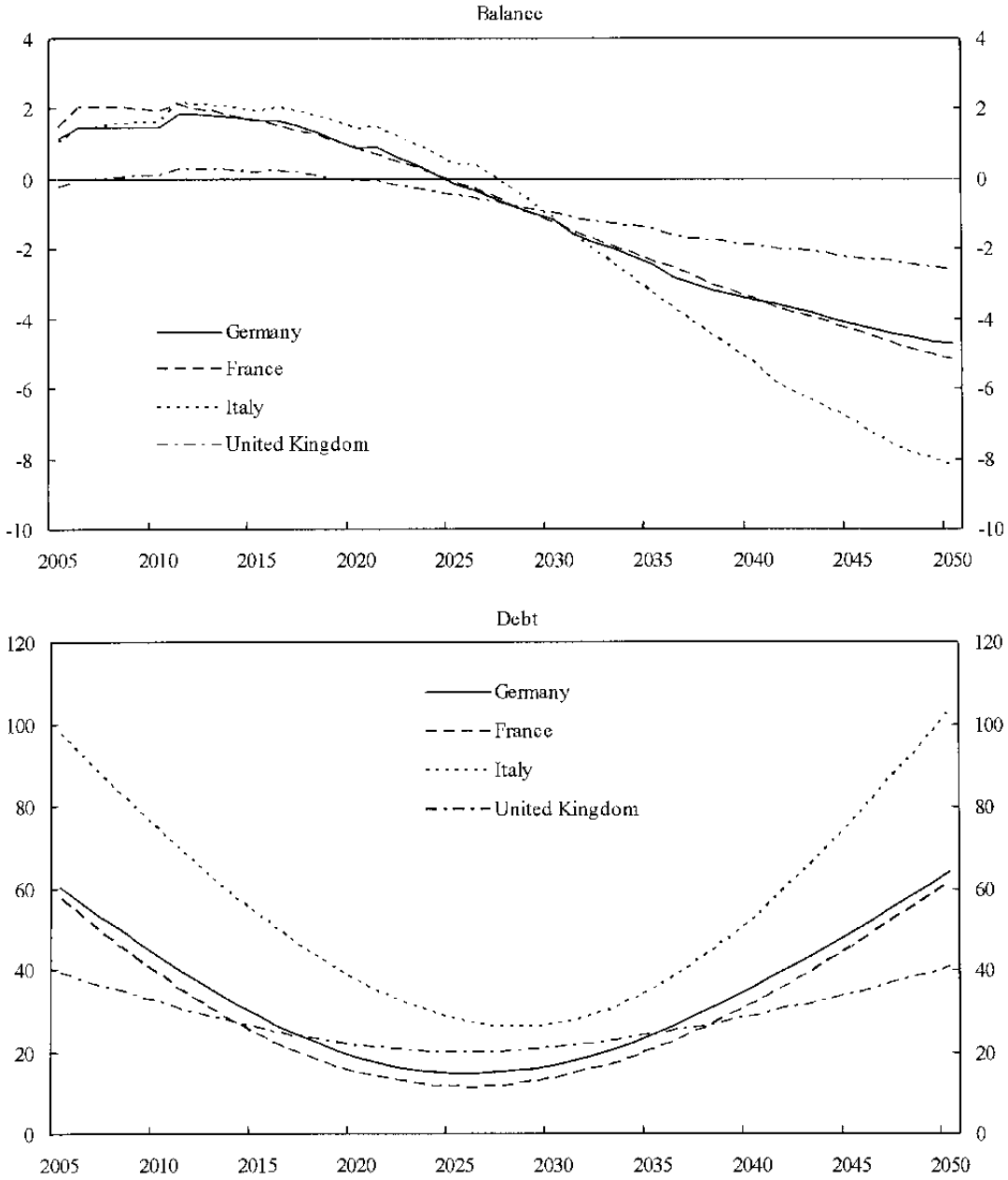
[13] The projections for the general government assume that the budgetary operations can be split up into the pension fund operations already described and a non-pension sphere. As regards the budgetary operations of the non-pension sphere, the ad hoc assumption is made that the government targets a primary surplus-GDP ratio that keeps the gross debt-GDP ratio constant at its 2004 (WEO) level. Alternative ad hoc assumptions, such as requiring the gross debt-GDP ratio to converge to 60 percent of GDP by 2015, could be used for pinning down the government's non-pension primary surplus target.

[14] This view is not uncontroversial; see Chand and Jaeger (1996, pp. 29-30) for a discussion.

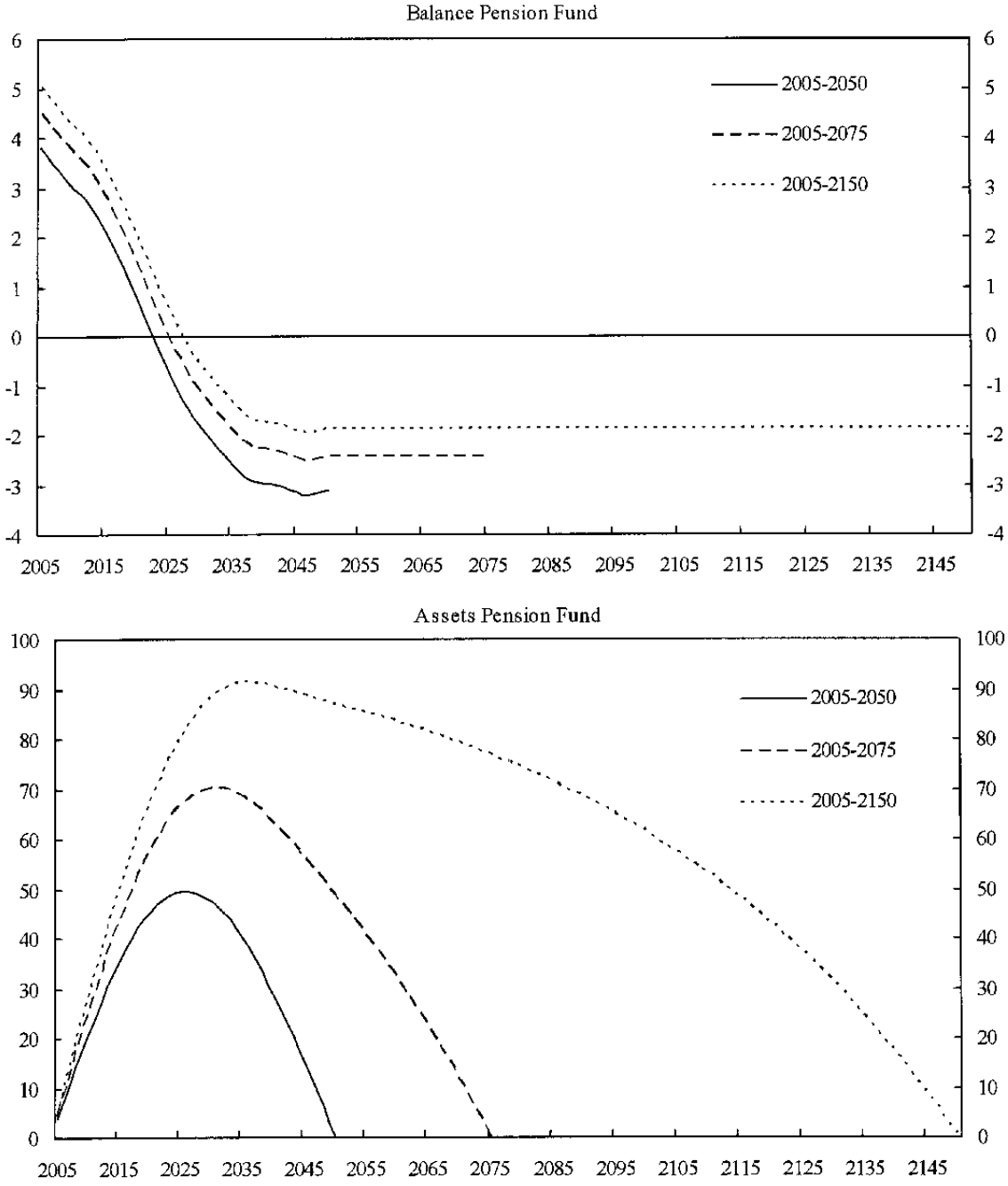
[15] The latest U.S. Social Security Trustee Report (2003) includes a projection that uses an infinite forecasting horizon. Projections of the pension-GDP ratio beyond 2050 were kept constant at the 2050 value.

Figure 4. Implications of Permanent Balance Approach for General Government Finances, 2005-2050
(In percent of GDP)



Source: Own estimates.

Figure 5. Permanent Balance Approach With Full Aging Passthrough:
Sensitivity of Germany's Results to Projection Horizon
(In percent of GDP)



Source: Own estimates.

reserve fund as future financing shortfalls have to be financed over more years. Furthermore, during the decumulation phase of the reserve fund, general government deficits could be quite large, clashing with the deficit and debt limits of the SGP. At the same time, this decumulation phase is still far in the future and one could argue that is therefore of little practical importance. It is also noteworthy that this problem does not arise under a prefunding scheme that reduces the public debt permanently to a lower level and uses the interest savings for additional spending on pensions.

14. **Prefunding, when applied to the large-scale public pension systems typical in continental European countries could raise some other issues:**

- Aging is likely to be a permanent shock, i.e. pension spending-GDP ratios will not revert back to an underlying equilibrium. As a result, the required build up of reserves becomes quite sensitive to the projection horizon, as illustrated by the sensitivity plots shown in Figure 5.

- The strategy does not directly address the adverse efficiency and distribution problems inherent in pension systems dominated by a large-sized public pillar. For example, large public pension pillars are typically associated with low employment rates of older cohorts, a dearth of equity financing, and low rates of return on pension savings for low-earning contributors (higher-earning individuals can typically top up their public pension with higher-yielding private pension savings).

- In the start up phase of the fund, while parametric spending reforms could be used to reduce the need for initial pension contribution rate increases, a significant rate increase would realistically have to be paired with parametric reforms cutting pension spending.

- The large size of required pension fund assets for the typical European country raises management and governance issues, particularly if the funds are invested in private equities. This point has traditionally been a key argument against public prefunding in Germany, as the implied indirect control of enterprises by a large-scale government fund was seen as incompatible with Germany's *Ordnungspolitik* (which sees the main role of government as providing a secure and unobtrusive framework within which markets can operate efficiently).

D. Parametric PAYG Reforms: Are Future Benefit Cuts Credible?

15. **A second stylized strategy for dealing with the fiscal imbalances due to aging is to stick to the PAYG financing approach.** But this requires setting out a plan that specifies ex ante parametric adjustments that closes looming financing gaps. Apart from the bracketed parameters in equation (4), this plan could also include adjustments on the pension revenue side. A prototype of such an ex-ante plan was introduced by Germany's 1992 Pension Reform Act, which envisages Germany's PAYG system as essentially operating on automatic pilot, with one-year-in-advance projections of financing shortfalls automatically

triggering increases in contribution rates (and budget transfers), which in turn feed back to reductions in the indexation of pension expenditure.

16. **A key issue is the credibility of such a strategy.** Leaving the spending side of a large-scale PAYG system untouched implies full pass-through of aging to pension spending and projected contribution rate (or tax rates) would have to increase by amounts that are not credible. In the particular case of Germany's pension system, reform discussions quickly resumed after the 1992 Pension Reform Act as projected contribution rate increases reached amounts that were not considered sustainable. But parametric adjustments on the pension spending side also raise credibility issues. (1) There are likely to be limits to the extension of retirement ages, and to be effective, increases in retirement ages would need to be accompanied by complementary labor market reforms. (2) Raising the employment rate (and therefore the number of contributors) has also limits and, moreover, creates more spending pressures later on when earlier contributors draw on their pension benefits. (3) This leaves pension benefit cuts as the main residual spending option, a fact well exemplified by the EPC (2001) projections for countries with low aging pass-through.

17. **The credibility of a pre-announced strategy of cutting future public pension benefits would have to be backed up by building up a private pension pillar.** Population aging will be accompanied by an unprecedented shift in older voters' share in the electorate, with older cohorts aged 55 or more likely to become a majority of the electorate in many EU countries as the greying of the population takes hold (Figure 6). A greying electorate is unlikely to accept an erosion of their public pension benefits if they are not able to compensate for the erosion in part from their own savings. This suggests that isolated parametric reforms of the public pension system that cut into pension benefits are unlikely to be time consistent if not accompanied by the build up of a compensating private pension pillar.

E. The SGP and the Fiscal Cost of Multipillar Transitions

18. **Shifting to a multipillar system that includes private prefunding but some deficit financing could be beneficial.** The argument that deficit-financed multipillar reforms can be welfare enhancing runs as follows: Most multipillar reform strategies require that pension contributions are partly diverted to private sector savings accounts. This creates a shortfall in the social security finances that can be compensated for from three sources: (1) cut public pension benefits of existing pensioners; (2) raise taxes to maintain public pension benefits; or (3) incur deficits and increase debt to avoid (1) and (2). Options (1) and (2) are likely to diminish the attraction of multipillar reforms considerably. Moreover, under certain assumptions, related in particular to distortionary effects of social contributions and the savings response of the private sector to a multipillar reform, option (3) can be welfare-enhancing in the sense that it increases the welfare of all generations involved.[16]

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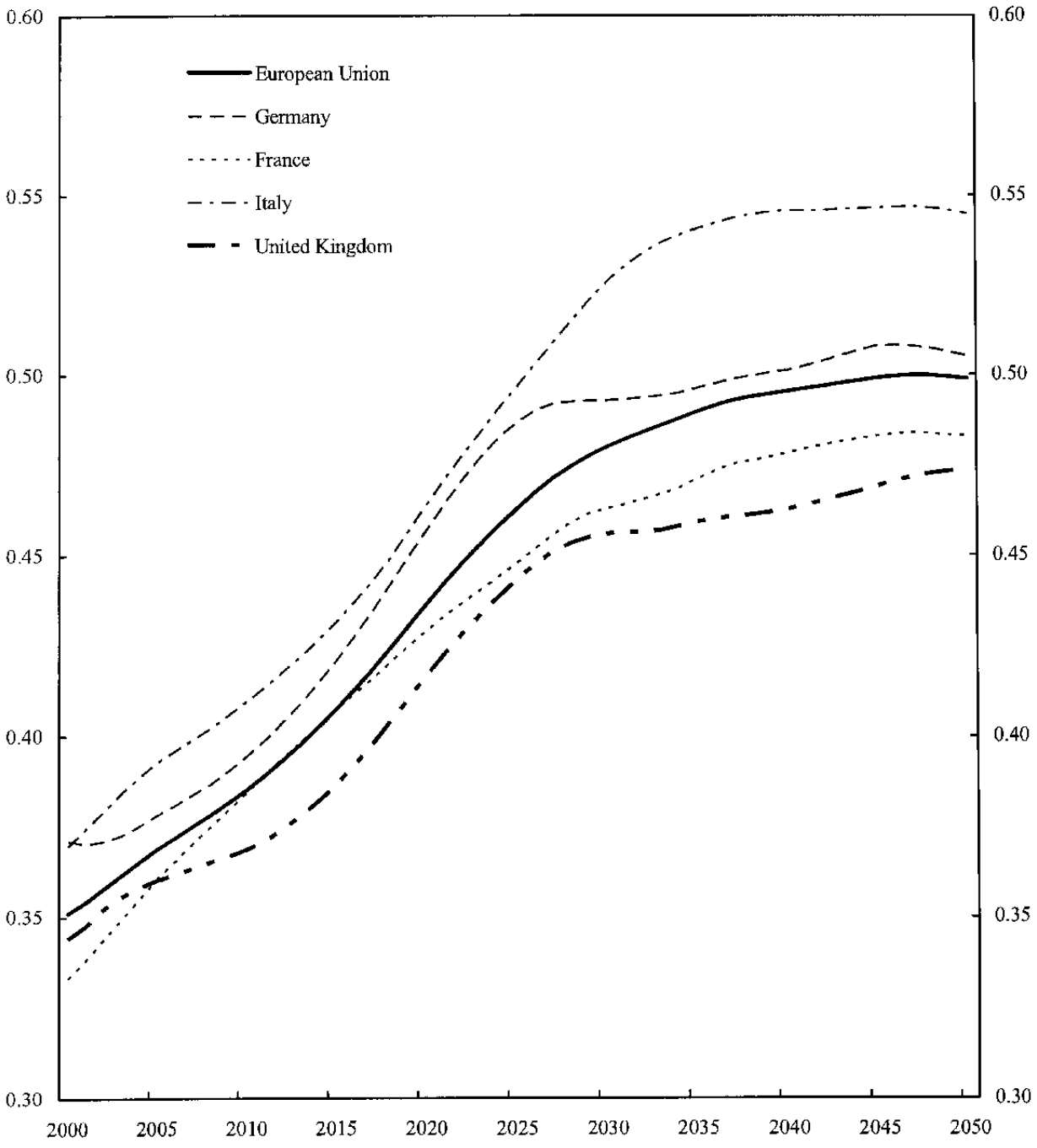
[16] See, for example, the simulations in Auerbach and Kotlikoff (1987).

Figure 6. Share of Elderly Voters in Total Voting Age Population, 2000-2050 1/



Source: EPC (2001).
1/ Defined as the ratio of population aged 55 and over to population aged 18 and over.

19. **The implied transition deficits for reforming large-scale public pension systems can be sizeable.** In the case of Germany, Chand and Jaeger (1996) estimated that the additional deficit due to a gradual but full shift to a privately funded pension pillar could eventually amount to 5-6 percent of GDP. While this stylized case clearly represents an extreme reform variant, more moderate transition regimes would also involve significant fiscal costs.

20. **While the qualitative case for some deficit financing of the transition to a multipillar system seems to be strong, quantifying the appropriate transition path may have to be done on a case-by-case and on a trial-and-error basis.** Modifications of the SGP that take account of the "optimal additional deficit" (OAD) due to multipillar pension reform are conceptually conceivable, the central difficulty is to pin down the OAD quantitatively. As illustrated by the discussion in Mackenzie et.al. (2001), the size of OAD depends on complex private sector reactions to the details of the reform, including the financial rate of return in the privatized system, whether the additional public debt used to finance the transition increases the interest rate, the degree of fiscal illusion in the private sector about the size of the implicit public pension debt, and the ultimate efficiency gains of the multipillar pension reform. No ready formula is likely to cover all these complexities, and implementation of transition paths may have to proceed on a flexible but cautious basis that monitors fiscal developments and private sector savings responses in real time.

F. The Difficulty of Agreeing on Pension Reforms: Is There An Information Gap?

21. **The implementation of pension reforms in Europe has proven a protracted process.** It has become a cliché to say that public pension reforms touch on the raw nerves of the political system, reflecting the significant intra- and intergenerational redistribution implications of most reform proposals. Proposals are usually quickly categorized (and dismissed) as "good" or "bad" and often become closely associated with political labels independently of merits.

22. **The public in European countries is generally well aware that pension systems are unsustainable.** Boeri et.al. (2002) present survey evidence on how well European citizens (in Germany and Italy) are informed about the outlook for their public pension systems. Clear majorities agreed with the statements that "pension systems will face a crisis in the next 10-15 years" and that "in the course of the next ten years there will be another pension reform reducing significantly the amounts of public pensions." It is noteworthy that Italy had gone through three reforms during the 1990s (Dini, Amato, Prodi reforms) and Germany had just adopted a multipillar system (Riester reform).

23. **But the public seems to be much less informed about the reasons for the unsustainability of pension systems and generally prefers the status quo.** In the cited survey, only a minority of the respondents seemed to understand how a PAYG pension system works (e.g. some 60 percent of the respondents thought that their contributions are accumulated in a pension fund for later payout) and few respondents had a clear idea of their relevant pension contribution rate (only 20 percent could locate their contribution rate in a

15-30 percent of gross earnings interval for Germany and 25-40 percent in Italy). At the same time, respondents overwhelmingly preferred the status quo, with both parametric reforms (higher contributions, lower benefits, later retirement) and the transition to multi-pillar systems lacking majority support and would-be reformers usually only supporting one particular reform proposal. While the distributional aspects of pension reforms will always be a potential stumbling block for proposals, this evidence suggests that lack of information on the functioning and cost of public pension systems could be associated with reform gridlock.

24. **Addressing the apparent information gaps revealed by these surveys could help the pension reform process.** More and better information may not necessarily break the reform gridlock in many countries. In fact, Boeri et.al. (2002) attribute reform gridlock to a large extent to intergenerational selfishness. But it is noteworthy that public pension reform debates (and reform debates more generally) have usually been helped by separating the provision of factual information about the outlook and cost implications of a given system from particular reform proposals. If this presumption is correct, the provision of regular reports on the longer-term outlook of public pension finances by credible agencies with no direct interest of their own in particular reform variants could have a catalyzing role. One benchmark for this type of report is exemplified by the annual report on the outlook for public pension finances regularly published by the U.S. Board of Trustees.

G. Conclusions

25. **This chapter's conclusions can be summarized as follows:**

- For sizing up the fiscal implications of population aging, it is useful to first establish benchmark projections based on "full aging pass-through" to public pension spending. The "full aging pass-through" benchmark allows ascertaining the implications of different parametric reform options required to maintain PAYG financing over a given time horizon. The benchmark also helps making transparent the implicit parametric reform assumptions incorporated in existing long-term projections of pension spending.

- A pension reform strategy focused on preventing aging-related fiscal imbalances by fully prefunding the public pension pillar would require most EU countries to run significant general government surpluses of about 2 percent of GDP for the next 15-20 years. As a result, a prefunding reform strategy implies "close to balance or in surplus" SGP norms that provide large safety margins relative to the 3 percent deficit limit, at least for the next 15-20 years.

- While clearly "SGP-friendly" and well-designed for restoring fiscal sustainability, a full-blown prefunding strategy for public pensions has some disadvantages in view of the large-scale monopillar pension systems typical for continental European countries. (1) Aging is likely to be a permanent shock, making prefunding requirements sensitive to the length of the assumed projection horizon. (2) Prefunding does not directly address the adverse efficiency and distribution problems inherent in

pension systems dominated by a large-sized public pillar. (3) Prefunding might require front-loaded contribution rate increases. And (4), the likely size of required public pension funds raises difficult governance issues, particularly if funds are invested in equity markets.

- Given the size of the aging problem, any pension reform strategy that deals effectively with aging-related fiscal imbalances is likely to require legislating substantial cuts in future public pension replacement rates. Such a strategy will, however, only be credible over the longer term—given rapidly graying electorates—if complemented by the build up of a private pension pillar that helps compensate for the future cutbacks in public pension benefits. This argument points to the need for an early buildup of privately funded pension schemes.

- This buildup of a substantial private pension pillar could, however, be costly in fiscal terms and may therefore not jibe well with present interpretations of the SGP. At the same time, the right approach for modifying the SGP to accommodate multipillar transition regimes is far from clear as it would depend on the details of the transition strategy as well as the private sector's savings reactions to the buildup of the private pension pillar.

- Finally, the chapter argues that the momentum for public pension reform in most European countries might be helped by having credible agencies that have no direct interest in particular reform variants publishing regular reports on the longer-term outlook of public pension finances. Recent survey evidence on how well European citizens are informed about the outlook for public pension systems suggests that citizens are generally aware that systems are unsustainable. At the same time, citizens seem to have little idea why their pension systems are unsustainable and this seems to account for survey findings that pension reform options generally lack a majority among voters.

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V. EU EASTERN ENLARGEMENT: IMPACT ON TRADE AND FDI [1]

A. Introduction

1. Eastern enlargement will expand the European Single Market to ten central and eastern European countries (CEEC10) by eliminating remaining barriers to the international flow of goods and services as well as capital and labor.[2] Drawing on the experience of previous enlargements, this paper argues that trade and investment links both between the old and new members and among the new members will deepen.

2. Enlargement can be expected to provide considerable stimulus to intra-industry trade and trade in "sensitive" products, while the impact on FDI is less certain but not likely to lead to large changes in volume compared with flows in the recent (pre-enlargement) period.[3] The new members will derive the largest share of the benefits of increased trade. The paper concludes that the overall impact on third-country trade and investment is likely to be limited.

B. Trade Impact

3. The EU concluded bilateral Europe Agreements with the CEEC10 in 1993-95. These agreements established free trade areas covering most products following an asymmetrical phase-in period. Bilateral trade increased rapidly both in the run-up to and following the conclusion of the agreements, as indicated by the experiences of the Czech Republic, Hungary, and Poland (Table 1). As a result, the EU has become the largest trading partner of the CEEC10 (Table 2).

4. Any increase in trade following enlargement is likely to differ across sectors. This is because under the Europe Agreements liberalization of trade in sensitive products and agricultural goods has been limited. Many non-tariff barriers remain, including anti-dumping actions, safeguards, complex rules of origin, and technical barriers. These are more prominent in some sectors than in others. Enlargement would be expected to stimulate trade in sensitive goods disproportionately.[4] But even for the bulk of goods that already trade with

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[1] Prepared by Jean-Jacques Hallaert.

[2] CEEC10 are Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovak Republic, and Slovenia.

[3] Sensitive products (textiles and clothing, coal and steel, cars, processed agricultural goods, and fisheries) are subject to special protocols. For agricultural goods, the Europe Agreements only provide privileged access to EU tariff-quotas. For more details, see Messerlin (2001) and OECD (1995).

[4] Table 1 indicates that growth in trade in agricultural goods has been more limited than growth in trade in industrial goods. The trade potential in "sensitive products" is

(continued)

few border restrictions, enlargement may have an impact as joining the Single Market entails increased competition, new opportunities for scale economies, and easier factor movements. During 1985-92, when the Single Market was negotiated and implemented, there was particularly strong trade expansion within the EU.

Table 1. Increase in Bilateral Trade with the EU
(Average annual change in percent)

	Period 1/	All goods	Agricultural goods 2/	Industrial goods 2/
Czech Republic	1990-97	26.9	18.6	27.4
Hungary	1990-97	22.8	8.4	24.6
Poland	1990-97	21.1	6.2	23.4
Memorandum item:				
Extra-EU trade	1990-97	6.9	5.3	7.0

Source: IMF staff estimates based on COMEXT database.
1/ Europe Agreements were signed with Hungary, Poland and Czech Republic in 1993.
2/ Agricultural goods: chapters 1 to 24 of tariff schedule; industrial goods: chapters 25 to 94.

5. The projected trade impact of enlargement varies according to the model used, but the CEEC10 are generally expected to derive a larger share of the benefits than the current EU members. Gravity model predictions differ, with some suggesting that there is significant potential for increased CEEC10 exports, and others less optimistic.[5] Havrylyshyn and Al-Atrash (1998) estimate that the share of CEEC exports to the EU could increase by 8 to 10 percentage points of GDP over 1996 for Poland and the Czech Republic, and by more for the other CEECs. On the other hand, Nilsson (2002) maintains that exports from CEEC10 and Cyprus to the EU have already exceeded their potential. General equilibrium analyses, such as Sulamaa and Widgrén (2003), predict a significant rise in CEEC exports[6] while, because of the difference in market size, the impact on incumbent EU members would be

controversial. For sensitive industrial products, Vittas and Mauro (1997) estimate that the potential for exports is very large, while Brenton and Di Mauro (1998) find little evidence for this.

[5] For the EU, Egger (2002) finds no unused export potential to the CEEC10, while Nilsson (2000) concludes that there remains some. Nilsson estimates the ratio of potential to actual exports at 1.1 in 1995-96.

[6] The increase in net exports would be more limited because of the increase in imports that is in part due to intra-industry trade and vertically-integrated production structure of multinational firms.

limited. For the same reason, Sulamaa and Widgrén expect a 0.7 percent increase in the CEECs real GDP, while the impact on EU members would be negligible.

6. Eastern enlargement is likely to stimulate trade among the CEEC10. Since the Europe Agreements are bilateral agreements, they do not cover trade between CEECs, and might have encouraged a "hub-and-spoke" pattern of trade. This risk appears to have been mitigated somewhat by regional trade agreements among the CEEC10. The CEECs have also concluded bilateral free trade agreements with each EFTA member and some CEEC10 have agreements with Turkey and other countries in south-eastern Europe. These agreements, however, vary significantly in scope, depth and administrative requirements, and fragment the European market.

Table 2. Share of EU in Total Trade
(In percent)

	2000
Bulgaria	50.3
Czech Rep.	66.3
Estonia	58.9
Hungary	69.1
Latvia	50.6
Lithuania	46.6
Poland	66.7
Romania	63.0
Slovak Rep.	52.7
Slovenia	66.0

Source: IMF.

7. By ending this fragmentation, enlargement can mitigate some of the trade diversion associated with the current plethora of agreements, as well as reduce transaction costs (especially relating to rules of origin despite the pan-European cumulation provision). This was also the experience, e.g. following the 1973 enlargement. Nilsson (2000) concludes that there is still unused potential for increased trade between some of the CEEC10.

8. Based on past experience, eastern enlargement is also expected to have a trade impact on third countries. For example, Greece's trade with EU countries jumped over 1978-87 (in constant terms), but decreased by 7 percent with third countries (Sarris and others, 1999). Along the same lines, Portugal's trade with the EU grew strongly starting in 1984 but its trade with third countries fell in proportion to its GDP (Porto and Costa, 1999).

9. The impact of enlargement on third countries will depend on several factors. On the one hand, enlargement is likely to divert some EU imports from third countries towards imports from the CEECs—barriers to trade between the EU and the CEEC10 are set to

disappear while those between third countries and the EU will remain. On the other hand, trade with third countries might expand if market access to the CEECs improves. The prospects in this regard are mixed. While adoption of the EU's common trade regime will reduce tariff protection for most CEEC10 (Table 3),[7] the incidence of non-tariff barriers and discriminatory measures may increase owing to the application of the Common Agricultural Policy (CAP), preferential regimes and EU trade defenses (such as anti-dumping).[8] Finally, to the extent that enlargement is successful at raising incomes within the enlarged EU, it will stimulate demand for third country products.

Table 3. Current Simple Average Import Tariff, Excluding Specific Duties and the Effect of Tariff Rate Quotas in Agriculture
(In percent)

European Union	4.8
Bulgaria	11.1
Czech Republic	6.1
Estonia	3.1
Hungary	11.7
Latvia	4.3
Lithuania	5.3
Poland	14.5
Romania	19.8
Slovak Republic	6.1
Slovenia	10.8

Source: Fund staff estimates.

10. Particularly because of the role of non-tariff barriers, the consequences of adoption by the CEEC10 of the Common Commercial Policy are difficult to model. Åslund and Warner (2003) compare Commonwealth of Independent States' (CIS) exports to the EU with those to the rest of the world during the 1990s and conclude that non-tariff barriers sharply curtailed

[7] As a result, the need for compensation of third countries under WTO rules is likely to be more limited compared with certain earlier enlargements. For details, see Yerkey (2003). GATT's Article XXIV entitles third countries affected by enlargement to seek compensation if an acceding country is required to raise tariffs on some products. Compensation usually has taken the form of lower duties on other products.

[8] For details, see European Commission (2003b).

the expansion of the former. They suggest that the eastward migration of these barriers under enlargement would similarly affect CIS trade with the CEEC10. However, these conclusions are not based on a formal modeling framework and the impact of enlargement on trade between acceding countries and CIS countries depends on several factors. Acceding countries will adopt the EU trade barriers that are relatively low in manufacturing and further reduced for CIS countries with Generalized System of Preferences (GSP).[9] However, although the acceding countries will drop existing safeguards against certain CIS exports, they will implement European anti-dumping actions and steel quotas that affect other CIS exports.[10]

11. Using the GTAP model, which incorporates only a subset of non-tariff barriers but allows for enlargement-induced changes in incomes, Sulamaa and Widgrén (2003) estimate that the impact of enlargement on trade with third countries will be limited.[11] Exports from the countries of the former Soviet Union (FSU) would increase by 1.5 percent from their 1997 level while imports would decline by less than 0.3 percent. The impact on trade with NAFTA is also relatively limited in this model, with exports expected to rise by 1.5-2.0 percent and imports declining by 0.5 to 0.9 percent. For the rest of the world, the impact is confined to an increase of less than 1 percent for both exports and imports.

12. Bayar (1999) applies the GTAP model to trade with the Southern Mediterranean countries. Assuming reforms to the common agricultural policy[12] and the planned phasing-out of textiles quotas, he estimates that export volumes would decline by almost 2 percent for Morocco and by 1 percent for the rest of the North African countries, while there would be little effect on other Mediterranean and FSU countries. Production of apparel in the CEECs would increase by 19 percent while it would decline in Turkey by 4.9 percent, in Morocco by 6.5 percent and in the rest of North Africa by 3.9 percent. However, these effects cannot be assigned in their entirety to the effects of enlargement.

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[9] Poland and the Czech and Slovak Republics will change their current GSP schemes for the EU scheme. The Czech and Slovak Republics already grant CIS countries preferences under their GSP scheme.

[10] Anti-dumping investigations initiated by the EU during 1997-2001 targeted three CIS countries (Belarus, Russia, and Ukraine).

[11] Note that GTAP, a computable general equilibrium model, is subject to a number of limitations. For instance, the 1997 GTAP database does not incorporate the majority of preferential trade arrangements and, perhaps most importantly, the model is static and does not account for trade-induced changes in investment patterns and productivity.

[12] The CAP reform scenario is a removal of output subsidies and border protection while input subsidies remain unchanged.

13. As far as agriculture is concerned, Liapis and Tsigas (1998) and Frandsen and others (2000) conclude that trade diversion is likely to be quite substantial for some products, but altogether, enlargement will be beneficial for the rest of the world. Liapis and Tsigas (1998) estimate the net welfare gain at $1.6 billion while Frandsen and others estimate it at $0.4 billion. Pelkmans and Casey (2003) argue that the CAP's eastern expansion would not lead to any significant trade diversion because CEEC10 agriculture is not competitive. CEECs exports of agricultural goods suffer from poor quality, a lack of investment, and absence of economies of scale. As a result of accession to the EU, many CEECs are likely to face large adjustment costs in the agriculture sector.

14. The European Commission (2003b) maintains that the impact of enlargement on third countries will be generally positive. At the same time, it has taken a number of initiatives that are, in part, aimed at mitigating any negative fall-out.[13] Most recently, in March 2003, the European Commission put forward a Communication that proposes to extend internal market and regulatory structures to all the neighbors of the enlarged EU, deepen preferential trading relations, create new instruments for investment promotion and protection, and provide support for integration into the global trading system and new sources of finance. Implementation is likely to require considerable time, and the impact of these initiatives will only be felt over the medium to longer term.

15. In addition to its impact on the volume of trade, enlargement is likely to change the structure of trade, with implications for adjustment costs. Changes in the structure of trade will depend on comparative advantage based on differences in endowments, as well as on the extent of potential economies of scale and preference for variety. The former would tend to stimulate inter-industry trade, while the latter gives rise to intra-industry trade.[14] To the extent that the increase in intra-industry trade dominates, adjustment costs could be more limited since it leads to specialization within industries rather than movements of resources between sectors.

16. Under the Europe Agreements, intra-industry trade between the EU and the CEEC10 has increased in importance.[15] It can be expected to grow further after enlargement. Several studies summarized by Greenaway (1989) suggest that EU membership has benefited intra-industry trade between members. Table 4 shows that this effect has been particularly marked

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[13] These include a series of bilateral Association Agreements, the Euro-Mediterranean Partnership (which aims for free trade both between the EU and the Southern Mediterranean countries, and among the latter), and Partnership and Cooperation Agreements with Russia, Ukraine and Moldova. See European Commission (1997, 2003a).

[14] Inter-industry trade can be defined as trade in different goods while intra-industry trade is the two-way trade of similar goods.

[15] Aturupane and others, 1999; Hoekman and Djankov, 1996

for new members following the enlargements of 1981 and 1986. Since accession of the CEEC10 would also entail participation in the Single Market, the effect may be still more significant. Indeed, during the period 1985-92 when the Single Market was negotiated and implemented, the level of intra-industry trade within the EU increased after about a decade of stability (Brülhart and Elliott, 1999; and Table 4).

17. Recent studies suggest that adjustment costs can differ depending on whether intra-industry trade is "vertical" (exchange of similar goods of different quality) or "horizontal" (exchange of similar goods that are differentiated by characteristics). Since vertical intra-industry trade (VIT) is more likely to be based on differences in endowments than horizontal intra-industry trade (HIT), which tends to be driven by imperfect competition and economies of scale, the adjustment costs are expected to be lower in the latter case.[16] During the 1990s, VIT accounted for 80 to 90 percent of the total intra-industry trade between the CEECs and the EU (Aturupane and others, 1999). Fontagné and others (1999) anticipate that enlargement will reduce *inter*-industry trade between CEEC10 and the EU and stimulate VIT, which has the largest potential for growth.

Table 4. Intra-Industry Trade Within the EU
(Unadjusted Grubel-Lloyd indices) [1/]

	1972	1977	1985	1992
EU 2/	0.57	0.59	0.58	0.64
1973 enlargement				
Denmark	0.41	0.44	0.42	0.47
Ireland	0.36	0.45	0.40	0.41
United Kingdom	0.65	0.71	0.62	0.68
1981 enlargement				
Greece	0.08	0.10	0.15	0.15
1986 enlargement				
Portugal	0.13	0.14	0.24	0.31
Spain	0.29	0.38	0.47	0.60

Source: Brülhart and Elliott (1999).
1/ The Grubel-Lloyd index ranges from 0 to 1. The closer the index is to 1, the more intra-industrial is trade. Calculated from SITC 5-digit for SITC 5-8 (manufactures). For all goods, the indices follow a similar pattern, but the level is lower.
2/ Average, weighted by values of intra-EU manufactured imports and exports.

[16] For details, see Brülhart and Hine (1999) and Greenaway and Tharakan (1986).

18. These results suggest that, despite the adjustment that already took place under the Europe agreements, enlargement could lead to a more difficult factor-market adjustment for the CEEC10 than the growth of intra-industry trade would suggest. Most of the CEEC10 exhibit levels of intra-industry trade significantly lower than that of Spain but comparable to those of Portugal or Greece. Collectively, the share of VIT in their total intra-industry trade with the EU is similar to the situation of Greece (Table 5).[17] However, the situation differs across countries, with e.g. the Czech Republic and Slovenia displaying high and rising shares of intra-industry trade and significant HIT trade, while for Bulgaria and Romania these shares are small and static. [18]

Table 5. Share of Intra-Industry Trade in Total Trade between CEEC10 and the EU (1996, in percent)

Average EU-CEEC10	29.8
Bulgaria	13.8
Czech Republic	47.7
Estonia	4.3
Hungary	37.3
Latvia	4.9
Lithuania	7.0
Poland	23.4
Romania	15.0
Slovak Republic	25.4
Slovenia	32.1

Source: Freudenberg and Lemoine (1999)

C. FDI Impact

19. Since the beginning of the transition, the inward FDI stock in the CEEC10 has grown more rapidly than in the rest of the world (Table 6). Most of this FDI has come from the EU (Table 7) and appears linked to the increase in trade in a variety of ways. For example, several studies suggest that the increase in FDI flows between the EU and CEEC10 is closely

[17] Aturapane and others (1999) estimate that the VIT of CEEC 10 was static over the period 1990-95. Freudenberg and Lemoine (1999) reach the same conclusion for each CEEC10 in 1996. According to Sarris and others (1999), VIT accounted for 80 percent of intra-industry trade of Greece with the EU before and after its accession.

[18] Brülhart and Elliott (1999) also reach this conclusion by analyzing the pattern of change in trade flows (through marginal intra-industry trade) of Greece, Portugal and Spain after their accession.

correlated with the increase in intra-industry trade (Hoekman and Djankov, 1996; Aturupane and others, 1999).[19]

20. Given the link between trade and FDI, a change in trade policy such as regional integration or enlargement provides an important stimulus not only to trade, but also to FDI (Yannopoulos, 1990; WTO, 1996; Brenton and others, 1999). In particular, by permanently removing remaining barriers to trade, enlargement allows firms to serve a larger integrated market from one or a few production sites, thereby to reap the benefits of scale economies. In addition, EU enlargement will end the "hub-and-spoke" pattern created by the bilateral Europe Agreements. Hub-and-spoke arrangements tend to distort the pattern of FDI because they provide an added incentive to locate FDI in the hub (the EU).[20] Lastly, enlargement will extend to newcomers the EU national treatment provisions and protection of intellectual property rights. As a result, CEECs might become a more attractive location for foreign investors.

Table 6. FDI Inward Stock

	1995 (mill. US$)	2001 (mill. US$)	Growth rate 1995-2001	Share in world stock in 2001
World	2,911,725	6,845,723	135 %	91 %
European Union	1,115,081	2,648,651	138 %	39 %
CEEC10	32,921	121,640	269 %	2 %

Source: UNCTAD.

21. Experience suggests that FDI anticipates enlargement. UK FDI in the European Community (EC) surged from 1971 in anticipation of the accession. The same phenomenon was observed preceding the Iberian accessions (Buckley and Artisien, 1987; Döhrn, 1996), as well as those of Sweden and Austria. Moreover, Brenton (1996) reports that FDI increased within Europe as early as the late 1980s in anticipation of the 1992 Single Market. Similarly,

[19] For a survey of the links between intra-industry trade and FDI, see Aturupane and others (1999).

[20] Investment in the "hub" conveys preferential access to the hub and *all* the spokes, while for a "spoke" location preferential access is limited to the host market and the hub

as noted above, FDI in the CEEC10 countries increased substantially during the 1990s, with most inflows coming from the EU (Table 7).[21]

22. Both FDI within the EU and from third countries into the EU grew after previous enlargements.[22] FDI inflows into Ireland from both non-EC and EC origins accelerated spectacularly in the 1970s (Yannopoulos, 1990). Spain accounted for 5.6 percent of total OECD inflows in the 1980s and 8.6 percent between 1990 and 1992; in contrast to 3.7 percent in the 1970s (Döhrn, 1996 ; Pelkmans and Casey, 2003). Portugal experienced a similar increase although later than Spain.

Table 7. EU Share in FDI Stock in CEECs
(1999, in percent)

Bulgaria	58
Czech Republic	84*
Estonia	85
Hungary	80*
Latvia	51**
Lithuania	64**
Poland	64
Romania	57
Slovak Republic	78*
Slovenia	81
CEECs	67

*: 2000 **: 2001
Source: UNCTAD.

23. There is no consensus on the prospects for FDI following the Eastern enlargement. UNCTAD (2002) and Brenton and Di Mauro (1999) estimate that the CEEC10 currently attract more or less the FDI that their market size would warrant and that all of them, except Slovenia, were above their potential for 1998-2000.[23] Nonetheless, UNCTAD also points out

[21] However, it should be noted that the increase in FDI inflows into the CEEC10 is linked to many other factors related to transition and it is not possible to isolate the contribution of the Europe Agreements or of the prospects of EU accession.

[22] This simultaneity must be interpreted with caution since inflows of FDI from third countries might also have been stimulated by factors other than enlargement such as the liberalization of capital flows, and of trade and administrative barriers to exports to the EU.

[23] See UNCTAD (2002) for a definition of the potential.

that most CEEC10 tend toward greater FDI potential and Döhrn (1996) projects FDI flows to increase significantly.

24. The location of FDI within the enlarged EU could be an issue of significant importance. Models of the "new trade theory" generally predict that a fall in trade barriers would promote the concentration and relocation of industries near their largest markets.[24] For example, many *ex ante* studies had concluded that both the formation of the EC and its enlargement would cause FDI to become more concentrated in the core of the EU to the detriment of peripheral areas. However, *ex post* studies have found little evidence of such concentration. A plausible reason is that differentials in labor and other costs compensated for agglomeration effects. Furthermore, FDI in services and network industries, which require greater closeness to customers, has been particularly prominent in recent years.[25]

25. Part of any increase in FDI might result from diversion at the expense of third countries. For example, there is evidence that in the early years of European integration, U.S. investment flows were redirected from the non-EC countries of Western Europe to the Member States of the European Community.[26] The main cause of FDI diversion are the relatively more attractive market access conditions to the EU market from location in the new members compared with third countries. While exports from the CEEC10 to other EU members will be unrestricted, exports from third countries will still face barriers such as rules of origin that can affect the location of FDI (WTO, 1996). Given the complex relations between FDI and enlargement, including the limitations mentioned above of any estimate of increased FDI into the enlarged EU, the scope for diversion—e.g. from the Mediterranean and FSU countries—is very hard to assess.[27]

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[24] See for example Helpman and Krugman (1985)

[25] Thomsen and Woolcock (1993) argue that the FDI location choice will mainly depend on industry characteristics such as distance costs and economies of scale. Industries for which both of these factors are significant will tend to concentrate their activity in a single location in the EU's core. In the reverse case, they will seek to benefit from differences in labor costs and invest in the periphery. Alternatively, industries with limited economies of scale and high distance costs will adopt a "localized" strategy. Finally, the strategy of industries with significant economies of scale and low distance costs (an important share of manufacturing industry), is difficult to determine a priori; in these cases the influence of national incentives and differences in regulations are likely to matter.

[26] However, it is difficult to ascertain whether the main reason was the regional integration process (Yannopoulos, 1990; WTO, 1995).

[27] For example, in their analysis of the impact of Eastern enlargement on third countries, Sulamaa and Widgrén (2003) quantify the impact on trade but only speculate that it may detract from FDI in Russia in favor of the CEEC10. Similarly, in their study of the

(continued)

26. The experience under NAFTA also provides some lessons. Monge-Naranjo (2002) reviews the surge in FDI into Latin America in the late 1990s. Inflows differed significantly across countries. He suggests that NAFTA induced sharply higher inflows into Mexico compared with the poorer countries in Central America, except for Costa Rica, which was able to attract massive FDI in higher-skill sectors (for which the attractions of NAFTA in terms of market access mattered little). Monge-Naranjo concludes that the pattern of FDI was related to differences in human capital and infrastructure across excluded countries. The "NAFTA bias" was particularly prominent in sectors that depended relatively little on either of these.

27. These observations suggest that, everything else being equal (including policies toward foreign investment), the impact of Eastern enlargement on FDI in third countries will depend on EU trade biases (most notably in agriculture and the textile and apparel sectors),[28] as well as on the ability of these countries to attract investment that is intensive in human capital and infrastructure.

D. Conclusions

28. Eastern enlargement will eliminate remaining barriers to trade between the CEEC10 and the EU. It will also simplify the map of European regional agreements and thus mitigate some of the trade diversion resulting from the current plethora of agreements. As a result, trade is expected to increase especially in industries for which trade liberalization under the Europe Agreements was limited. Moreover, enlargement is not expected to have a significantly negative impact on third countries. Most of the increase in trade in the enlarged EU is expected to be intra-industry trade. While this could mitigate adjustment costs, for some of the CEEC10 much of the potential would appear to be in vertical intra-industry trade, which does entail a certain amount of dislocation.

29. Enlargement may stimulate FDI flows, owing in part to the increase in market size and elimination of all barriers to trade and of lower policy and institutional risk in the new members. However, to a significant extent, location choices will depend on industry characteristics and are uncertain in the aggregate. Previous enlargements suggest that FDI from outside the enlarged EU might increase as well, and it is possible that part of the

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consequences of EU enlargement for the CIS countries, Åslund and Warner (2002) estimate that CEEC10 are likely to receive additional FDI of about 4 percent of GDP but provide no indications of the impact on CIS countries.

[28] See Bayar (1999) for the importance of these sectors for the Southern Mediterranean countries. Monge-Naranjo (2002) indicates that in the case of NAFTA the most severe bias is in the textile and apparel sectors, which represented most of the FDI flows in Honduras, El Salvador and Guatemala, but not Costa Rica, a country that attracted FDI for the production of electronic components, medical equipment and other higher-end products.

increase would be diverted from third countries. However, the complexity of the relations makes it difficult to quantify FDI diversion.

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