

EUROPEAN MONETARY POLICY: CAN THE ECB LEARN FROM THE FED?#

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Abstract

Analysts often blame the ECB for its slow and muted reaction to the business-cycle contraction at the beginning of the 2000s. They point to the example of the Fed, which supported vigorously real growth through an activist monetary policy strategy. In this paper I present evidence questioning the popular notion that the Fed was more effective in combating the contraction than the ECB. The effectiveness of the Fed's actions was undermined by the fact that the data on real growth, available at the beginning of the 2000s, overstated substantially the health of the US economy. Thus, the Fed waited too long in easing monetary policy. Recent Fed experience demonstrates that fuzzy economic data may complicate a central bank's task of charting an appropriate monetary policy course. Even though a sound monetary policy strategy is likely to be activist, objections of monetarists against activism retain a kernel of truth.

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I. Introduction

Analysts comparing the monetary policy strategies followed by the US Federal Reserve System and the European Central Bank frequently criticize the "orthodox" approach of the Frankfurt institution. They blame the ECB for sticking too closely to its mandate of achieving and maintaining price stability. In their view, the ECB should pay more attention to output and employment. Analysts calling for a greater focus on real growth typically point to the example of the American central bank. Under the leadership of Chairman Greenspan, the Fed has attempted to support real growth without jeopardizing price stability. In principle, the Fed has endeavored to respond actively to shocks that are likely to harm the US economy either by fuelling inflation or by lowering output and employment. The Fed's activism, analysts argue, compares favorably to the more sluggish approach of the ECB, reflecting the monetarist tradition of the German Bundesbank. Monetarists rejected central-bank activism. Considering the long and variable lags in the effects of monetary policy, they maintained that central-bank activism would do more harm than good to the economy. Does recent US experience refute monetarists' fears, that is, should the ECB try to emulate the Fed and switch to a more activist approach aimed at supporting real growth in addition to guaranteeing price stability?

The answer to this question involves both fundamental and practical issues. At the fundamental level, it is necessary to distinguish between sound and unsound central-bank activism. While monetarists were right in rejecting unsound activism, a sound activist approach may help central banks to improve their policy performance. At the practical level, this paper leads to a surprising conclusion: In principle, both the Fed and the ECB followed sound activist strategies and responded to adverse shocks in similar ways. In particular, it is too simplistic to argue that the ECB behaved more sluggishly than the Fed. Notably during the cyclical contraction of 1999-2001,

the Fed's response to the adverse shock was not as rapid as is widely believed, despite its professed desire to pursue an activist strategy. For this reason, it is unclear whether the Fed was more effective in supporting real growth than the ECB.

II. Should Central Banks Follow an Activist Policy Approach?

In the 1950s and 1960s, Milton Friedman (1959) and other leading monetarists rode strong attacks on central-bank activism. They argued that activist monetary policies had often yielded counterproductive results since they had magnified, rather than mitigated, cyclical and other short-run fluctuations in economic activity. In particular, they objected to central banks pursuing multiple and varying monetary policy goals. At that time, the Fed and other central banks frequently shifted between policy goals. During recessions, they adopted expansionary monetary policies in an effort to stimulate real growth and employment. Typically, the easy stance led to inflation, compelling central banks to tighten their monetary reins again. For this reason, monetarists insisted that central banks should abstain from activism and instead base their monetary policies on simple and transparent rules. The rule proposed by monetarists involved growth targets for the money supply that would tie the hands of activist central banks. The sharp worldwide increase in inflation toward the end of the 1960s and the beginning of the 1970s led many central banks and governments to reconsider the wisdom of traditional activist approaches and to adopt monetary targets of various sorts.

Monetary targets frequently assisted central banks in reducing inflation to low levels. However, they turned out to be less helpful as monetary policy guides after price stability had been restored. While money growth may act as a useful warning signal of inflation dangers lurking in the distant future, it provides little advance information on imminent threats to price stability. In particular, money growth is

largely incapable of predicting cyclical movements in the inflation rate. Therefore, expanding the money supply at a steady pace, as the monetarists recommended, may forestall secular inflations or deflations, but it is unlikely to help much in preventing even sharp price increases during business-cycle expansions or analogous price decreases during business-cycle contractions.¹

Considering the limited information content of money growth, central banks cannot but monitor other indicators in order to forecast future changes in the price level. As far as cyclical movements in the inflation rate are concerned, the output gap is an important determinant of future price changes. If output exceeds its potential level, an economy suffers from labor shortages and production bottle-necks, driving up prices and wages. By contrast, with output below its potential level, an economy is saddled with high unemployment and excess productive capacities, putting downward pressure on prices. Central banks intent on maintaining low inflation both over the business cycle and in the long run, therefore, must take account of the output gap in setting monetary policy. Since measuring the output gap raises a host of difficulties, central banks in practice monitor a variety of indicators furnishing information on the cyclical state of the economy.

Provided central banks monitor a variety of cyclical indicators, their policy strategies are bound to become activist. They do not stick to a steady policy course defined by a rigid monetary target. Instead, they adjust monetary policy whenever new information derived from their monitoring process points to a major inflation or deflation threat. Although these central banks defy the monetarist verdict against activism, their policy strategies need not imply a return to the bad old days of the

¹ This was certainly the experience of the Swiss National Bank, which had been a partisan of monetary targeting until the end of 1999. The SNB was able to keep the inflation trend at a low level, but could not prevent a resurgence of inflation during business cycle expansions. See Rich (2003) for a more detailed discussion of this point.

inflationary 1960s and 1970s. It is important to stress that activism may rest on a sound or unsound footing.

A sound activist approach remains in sympathy with monetarist prescriptions in the sense that it rests on a well-designed monetary policy framework likely to guarantee price stability. Unlike the simple monetary targets favored by monetarists, the policy framework guiding activist behavior is complex. To prompt central banks to forestall properly threats to price stability, such a framework compels policy makers to adjust their policy instruments – today normally a short-term interest rate – to major changes in such variables as the inflation rate, the output gap, money growth and the exchange rate. Moreover, policy makers should react to changes in these variables in a stable and predictable manner. In more technical parlance, central banks should set monetary policy on the basis of a stable and predictable reaction function.² That such a framework is unlikely to be simple is a fact of central-bank life. Even monetarists (e.g., Meltzer, 1987) now admit that a well-designed policy framework may prompt central banks to vary their monetary targets and instruments frequently.

In a well-designed policy framework, the output gap is bound to play an important role as it provides advance information on future inflation. Even if price stability serves as the overriding objective of monetary policy, central banks may have to react to major changes in the output gap because of its indicator function. In practice, it does not matter much whether a central bank attempts to pursue both price and output stability, as in the case of the Fed, or whether it is committed mainly to secure price stability, as in the case of the ECB. So long as the policy framework employed is designed to prevent sustained inflations or deflations, both types of

² A relatively simple and popular example of such a reaction function is the well-known Taylor rule, linking the central-bank instrument to the inflation rate and the output gap.

central banks are likely to behave in similar ways although they may not attach the same weight to output in their reaction functions. Thus, a policy framework designed to avoid sustained inflations and deflations will help to moderate cyclical fluctuations in output and employment too.

Needless to say, these comments also apply to central banks setting monetary policy on the basis of inflation targets and inflation forecasts, as has become popular in recent years. Ideally, the inflation forecast should capture all the information derived from indicators furnishing advance information on future inflation. Even if a central bank is committed to an inflation target, it is bound to react to major changes in the output gap because such changes tend to impinge on the inflation forecast.³

Reacting to the output gap within a well-designed policy framework contrasts sharply with the unsound monetary policies prevalent in the 1960s and 1970s. Central banks relying on a sound policy framework do not switch continuously between policy goals. They do not pursue price stability today and output stability tomorrow. They are clearly aware of the fact that they cannot be all things to all people. In particular, they cannot promise and deliver high output and employment at all times. Instead, they must content themselves with trying to moderate short-run fluctuations in output and employment if they are to maintain price stability.

III. The Fed and ECB Strategies in Practice: A Surprising Result

A highly welcome development of the past two decades has been a remarkable shift in the prevailing paradigm guiding central-bank behavior. Most governments and central banks, most economists and wide segments of the public now agree that monetary policy should be aimed mainly at achieving and maintaining price stability.

³ See Freedman (1995) for a discussion of this point.

Thanks to the shift in paradigm, global inflation has decreased dramatically and price stability has been restored in many parts of the world. If there remains disagreement about the monetary policy strategies to be followed by central banks, it concerns the scope policy makers possess for stabilizing cyclical and other short-run fluctuations in the output gap. Consequently, the question arises whether central banks in practice differ in the way they react to fluctuations in the output gap. In the following, I examine and compare the reaction patterns of the Fed and the ECB. Does the evidence imply that the Fed was more supportive of real growth than the ECB as many analysts suggest?

Figs. 1 and 2 describe the relationship between the US federal funds rate and the euro-area overnight lending rate, on the one hand, and consumer price inflation and real GDP growth on the other. The data on interest rates are quarterly averages of daily rates. They cover the period since the beginning of 1999, when the ECB assumed responsibility for monetary policy. Inflation is measured by the annualized quarter-on-quarter percentage changes in the CPI, calculated from the corresponding seasonally-adjusted average monthly index data.⁴ Moreover, I employ seasonally-adjusted and annualized quarter-on-quarter growth rates for real GDP, rather than for the output gap, due to the difficulties of measuring the latter variable. However, since it is unlikely that potential output growth changed dramatically over the sample period, the fluctuations in the growth of real GDP and the output gap should be highly correlated.

In the case of both the Fed and the ECB, short-term interest rates moved more or less in line with inflation. Moreover, with a lag of several quarters, they also reacted to major fluctuations in real GDP growth. As may be seen from Figs. 1 and 2,

⁴ The seasonal adjustment rests on the X12 procedure. See the table for the data sources.

both central banks lowered short-term interest rates in response to the slump in real growth setting in during the second half of 1999. However, they allowed several quarters to elapse until they adjusted monetary policy to the deterioration in economic activity. Although US real growth attained its cyclical peak in the fourth quarter of 1999, the Fed did not start to lower the federal funds rate until January 3, 2001, that is, almost five quarters later. The ECB waited even longer than the Fed before it decided to cut interest rates. While euro-area real growth reached a cyclical peak in the third quarter of 1999, the ECB decided to ease monetary policy on May 11, 2001, that is, only after seven quarters had passed. The ECB was reluctant to ease monetary policy in response to the cyclical contraction because of its concern about inflation, which had moved above its threshold of 2 percent in the course of 1999.

Comparing the lags between the cyclical peaks of real growth and interest rates appears to confirm analysts' complaints about an overly sluggish ECB response to the 1999 downturn. However, the two figures also reveal another fact that has largely gone unnoticed. From 2001 to 2003, the ECB gradually lowered interest rates in step with the cyclical contraction in real GDP growth. Although interest rates in the euro area declined less and more slowly than in the US, this did not reflect ill-advised caution on the part of the ECB. Rather, the cyclical contraction in the euro area was milder and more drawn out than in the US. In contrast to the ECB, the Fed did not lower interest rates in tandem with the cyclical contraction. Against the background of an exceedingly sharp slump in US real GDP growth, the Fed was slow in reducing interest rates. As a result, the lag between the federal funds rate and real GDP growth lengthened considerably in the course of the cyclical contraction. While the Fed reacted more quickly than the ECB upon the turn in the business cycle, it was

slow in recognizing the severity of the contraction and in charting an appropriate policy response.

To gain further insights into the response patterns of the Fed and the ECB, I estimate econometrically reaction functions for the two central banks. The regression equations explain movements in short-term interest rates over the period 1999:1 to 2003:4. Short-term interest rates are related to a constant, the inflation rate, lagged by one or two quarters,⁵ and to real GDP growth, lagged by a varying number of quarters. The results are displayed in the first and third columns of the table. In the case of the US, the best fit⁶ is obtained if real GDP growth is lagged by 7 and 8 quarters. In the case of the euro area, the best fit involves 4 and 5 quarters. The estimates displayed in the table confirm the impressions gained from Figs. 1 and 2. In the case of the Fed, the average lag between the interest rate and real GDP growth was almost twice as long as in the case of the ECB. However, even though the lag between the federal funds rate and real growth averaged almost two years, once the Fed had recognized a need for action, it began to cut interest rates decisively. As indicated by the estimated coefficients, for every one-percentage-point fall in real GDP growth, the Fed cut the federal funds rate by 0.33-0.35 percentage point, while the corresponding reduction in the Euro-area overnight lending rate was smaller in that it amounted to only 0.15-0.28 percentage point.

I should note that estimating reaction functions for the Fed raises certain difficulties caused by multicollinearity in the independent variables. There exists a significant positive correlation between the inflation rate, on the one hand, and real

⁵ If the inflation rate is lagged by more than two quarters or if its contemporaneous value is included, the explanatory power of the equations deteriorates substantially.

⁶ I assess the goodness of fit on the basis of the unadjusted and adjusted R^2 , the standard error of the estimate, the t-statistics, as well as the Akaike and Schwarz criteria. Note that the Durbin-Watson statistic leaves something to be desired.

GDP growth two and three quarters earlier on the other. It is likely that this relationship reflects the advance indicator role of the output gap for inflation, mentioned in Section II. Considering the correlation between inflation and real growth, I cannot rule out the possibility that the estimates in the first column provide a mistaken view of the Fed's behavior. Instead, the Fed may have reacted to inflation, lagged by one quarter, and to real growth lagged by three and four quarters. To test for the possibility of misspecification, I relate – in the second column of the table – the federal funds rate to inflation, lagged by one quarter, and to real growth, lagged by three, four, seven and eight quarters. Of course, such a reaction function does not make much sense, as it is implausible that the Fed took account of real growth in both the immediate and distant past. Nonetheless, all the estimated coefficients, except that for the constant, are statistically significant. Since the coefficients for real growth in the distant past display the highest t-values, this piece of evidence lends support to the view that the Fed reacted to real growth recorded seven and eight quarters earlier, while the statistically significant coefficient estimates for real growth in the near future mirror multicollinearity with the inflation rate.

Further evidence of misspecification is obtained by applying a Wald-test to the regression equation shown in the second column of the table. I explore the null hypothesis that the pair of regression coefficients for real GDP(-3) and real GDP(-4) jointly amount to zero. On the basis of the F-statistic, the null hypothesis can be rejected only at the 98.7 percent level of significance. By contrast, an analogous null hypothesis of zero coefficients for real GDP(-7) and real GDP(-8) is rejected decisively.⁷ Thus, in all likelihood, a properly specified reaction function for the Fed

⁷ I also ran a regression including as independent variables the inflation rate, lagged by one quarter, and all the lagged real GDP growth rates from three to eight quarters. For this equation, analogous Wald-tests yielded the following results: Rejection of the null hypothesis at the 99.3 percent significance level for the pair of lags -7 and -8, decisive acceptance for the pair of lags -6 and -5, and

includes solely the independent variables displayed in the first column of the table. All in all, I cannot help concluding that the Fed was not as effective in supporting real growth as is widely believed.

The long delay in the Fed's response is puzzling in view of its strong desire to combat the contraction of 1999-2001. The explanation for the Fed's seemingly odd behavior lies mainly in the difficulties of assessing correctly the cyclical state of the US economy. At the beginning of 2001, the Fed believed that it had relaxed monetary policy speedily in response to the sharp downturn in economic activity. However, as the data on real GDP were revised, it became evident that the economy had started to contract already during 1999. Fig. 3 compares the data on real GDP growth, as initially announced by the US Department of Commerce ("original"), with the version based on the most recent revision ("most recent").⁸ As may be seen from the figure, the data for the period 1999-2001 were revised down drastically. Obviously, the real GDP data available in 1999 and 2000 overstated the health of the US economy and led the Fed to stick to its then restrictive course longer than was necessary to quell potential inflationary dangers.

Provided the Fed's reaction function is estimated with the original real GDP data, the response to changes in real growth is shortened considerably. The results obtained for the original data are displayed in the fourth and fifth columns of the table. Clearly, the lags between the interest rate and real GDP growth shrink from seven and eight to two and three quarters. If the original, rather than the most recent, data are used, the inflation rate becomes significant only if it is lagged by five quarters, a result that makes no sense. However, this estimation problem does not

rejection only at the 95 percent level for the pair of lags -4 and -3, as well as for the combination of lags -6, -5, -4 and -3.

⁸ The "most-recent" version incorporates all the revisions up to the end of February, 2004. This version is also displayed in Fig.1.

matter much since I focus on the link between interest rates and real GDP growth. For the latter, the best fit involves lags of two and three quarters, regardless of the specification chosen for the inflation rate. Considering the real-time data available to the Fed, the US central bank reacted quickly indeed to the cyclical contraction of 1999-2001, as has been stressed approvingly by analysts.

Data revisions also complicated the task of the ECB, but they were less bothersome than in the US case. Fig. 4 exhibits the most recent data on euro-area real GDP growth and the version ("original") initially published in the ECB's *Monthly Bulletin*.⁹ In contrast to the alterations in the US data, the euro-area revisions did not lead to noticeable shifts in the cyclical turning points of real GDP growth. Nonetheless, the European data revisions also repainted somewhat the picture of the contraction drawn by the original statistics. As may be seen from Fig. 4, in the initial stage of the contraction, i.e. from the summer of 1999 to the summer of 2000, euro-area real GDP growth slowed more sharply than had originally been believed. At that time, many European policy makers argued that the euro area would be able to insulate itself from the US recessionary bacillus. Accordingly, the ECB did not see a need for a quick response to the deteriorating international environment. For this reason, the lag between the turning point in real GDP growth and the overnight lending rate was relatively long. However, when the ECB came to recognize the severity of the downturn, it did not hesitate to act. As may be seen from the third and last columns of the table, the ECB's reaction lag to changes in real GDP growth is shortened by one quarter provided the original data are substituted for the most recent ones. Interestingly, on the basis of the original data, the principal difference

⁹ The procedure for calculating the original data on real GDP growth in the euro area is explained in the legend to the table. The original growth data, as extracted from the ECB's *Monthly Bulletin*, are available back to the fourth quarter of 1997. As in the US case, the most recent euro-area data incorporate all the revisions up to the end of February, 2004

between the Fed and the ECB did not lie in the length of time they needed to react to the cyclical contraction in economic activity. The ECB's lag to real GDP growth of three and four quarters was only three months longer than that of the Fed. Rather, once the two central banks had decided to act, the Fed responded much more vigorously than that the ECB. As may be seen from the fifth and sixth columns of the table, for every one-percentage-point decrease in original real GDP growth, the Fed lowered the federal funds rate by roughly 0.5 percentage point, while the ECB cut the overnight lending rate by about 0.25 percentage point.

To sum up, analysts' complaints about the ECB's failure to support real growth are clearly exaggerated. If revised data on real GDP growth are employed, the ECB – surprisingly – reacted more quickly to the cyclical contraction of 1999-2001 than the Fed. However, once the two central banks had relaxed their monetary policies, the Fed acted more vigorously in cutting short-term interest rates than the ECB. If the data on real GDP growth initially published are used, the reaction patterns for interest rates become more akin to analysts' views about behavior of the two central banks. However, even in this case, the ECB's response was not as tardy as is widely believed.

IV. Summary and further Comments

If a lesson can be learned from recent Fed experience, it is not that the US central bank was highly successful in supporting real growth. The Fed's efforts of counteracting the contraction of 1999-2001 were hampered by a dilemma central banks frequently face. Ideally, they should attempt to offset, through a sound activist policy strategy, major shocks threatening to disturb price stability. However, in practice, implementing such a strategy runs up against various difficulties. In particular, fuzzy macroeconomic data may mislead policy makers into taking

inappropriate policy decisions.¹⁰ Analysts in recent years have often praised the Fed for its alleged ability to support real growth without endangering price stability, while they have been more critical of the ECB's strategy. The episode of 1999-2001 contains an important message: Even the most astute central bank can make mistakes because it is saddled with fuzzy data when setting its policy course.

Although the Fed – with hindsight – waited too long in responding to the cyclical contraction of 1999-2001, it does not follow that its activist approach was entirely wrong. On the contrary, after it had decided to switch gears, its determined response to the contraction was instrumental in helping the US economy to return to a recovery path. Not least because of the Fed's activist countercyclical monetary policy, US real GDP began to accelerate strongly in the summer of 2003, while inflation remained benign. Therefore, fuzzy data often complicate central banks' task of charting appropriate monetary policies, but they do not preclude the pursuit of sound activist strategies. Nonetheless, monetarist skepticism about the wisdom of central bank activism retains a kernel of truth. While central banks are well advised to follow sound activist strategies, they should refrain from promising too much to the public. Sound activist strategies may contribute to mitigating cyclical fluctuations in real growth and employment, but they cannot eliminate entirely the business cycle. Due to the complications arising from fuzzy data, central banks are likely to jeopardize their main objective of price stability if they endeavor to "fine tune" the economy by trying to offset completely cyclical shocks to economy activity.

In the initial stages of the 1999-2001 contraction, fuzzy data also led the ECB to exaggerate the health of the economy. However, the euro-area data on real GDP growth initially released were less misleading than their US counterparts. For this

¹⁰ See Orphanides (2001) for a more detailed discussion of this point and similar evidence pertaining to earlier periods.

reason, the ECB, contrary to analysts' assertions, ended up lowering interest rates more quickly than the Fed in response to the slump in economic activity. However, once the decision of relaxing monetary policy had been taken, the Fed adopted a more determined countercyclical stance than the ECB. In view of the available evidence, it is unclear whether the Fed did a better job at combating the recession than the ECB.

Of course, critics of the ECB might argue that the relatively poor performance of the euro-area economy in the recent past lends support their accusations. While US real growth took off in the summer of 2003, the recovery of the euro-area economy has been disappointingly sluggish. Needless to say, monetary policy is unlikely to be the only factor behind the current recovery. Nevertheless, the ECB – recently – has followed an overly cautious approach even though it reacted quite speedily to the cyclical contraction of 1999-2001. During its first years of operation, the ECB was rightly concerned about its credibility. Since inflation still exceeded its threshold of 2 percent (Fig. 2), its room for maneuver in counteracting vigorously the recession was limited. Considering its price-stability mandate, the ECB had to exercise caution in relaxing monetary policy. However, in the meantime, inflation has slowly moved back to the range the ECB defines as price stability. In December 2002, the ECB (2002, p. 58) already forecasted that in 2004 inflation, measured in terms of the harmonized index of consumer prices, would drop to a range of 1.0-2.2 percent. In other words, it expected that inflation, in all likelihood, would fall below its threshold of 2 percent in due course. Since the ECB basically maintained this favorable forecast in June and December, 2003,¹¹ it would have possessed some scope for relaxing monetary policy further, especially as it became evident that

Europe would enjoy an anemic recovery at best. As a matter of fact, the ECB's forecasts were borne out by subsequent developments as inflation dropped below the threshold at the beginning of 2004.

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¹¹ The ECB publishes staff forecasts for inflation and real GDP growth in June and December. The inflation forecasts for 2004 amounted to 0.7-1.9 percent in June (ECB, 2003a, p. 64) and to 1.3-2.3 percent in December, 2003 (ECB, 2003b, p. 58).

Determinants of Interest Rates, 1999:1-2003:4

Variable or test statistic	GDP most recent			GDP original		
	US		Euro area	US		Euro area*
Inflation (-1) (t-statistic)	0.91 (3.71)	0.50 (2.22)				0.38 (2.58)
Inflation (-2)			0.43 (2.98)	0.36 (1.21)		
Inflation (-5)					0.73 (2.75)	
Real GDP (-2)				0.44 (2.84)	0.45 (3.25)	
Real GDP (-3)		0.25 (2.48)		0.36 (2.11)	(0.56) (4.16)	0.25 (2.03)
Real GDP (-4)		0.24 (2.42)	0.15 (1.46)			0.23 (1.96)
Real GDP (-5)			0.28 (2.76)			
Real GDP (-7)	0.33 (2.90)	0.28 (3.11)				
Real GDP (-8)	0.35 (3.03)	0.32 (3.53)				
Constant (t-statistic)	-0.80 (-1.02)	-0.92 (-1.50)	1.58 (4.61)	0.32 (0.42)	-1.30 (-1.43)	1.78 (5.33)
R ²	0.71	0.84	0.68	0.66	0.77	0.68
R ² adjusted	0.65	0.79	0.62	0.59	0.73	0.62
Standard error of regression	1.23	0.96	0.55	1.33	1.13	0.55
Durbin-Watson statistic	1.35	1.49	1.25	0.68	1.15	0.95

* The coefficients for Real GDP(-3) and Real GDP(-4) are statistically significant only at the 90 percent level. For this reason, I test the null hypothesis of the two coefficients jointly assuming the values of 0.25 and 0.23 respectively. Based on the F-statistic, the Wald-test leads to an acceptance of the null hypothesis at the 99.7 percent level of significance.

Legend to Table

Data sources:

US real GDP, most recent data: US Bureau of Economic Analysis.

US real GDP, original data: Numbers first announced in US Department of Commerce, *Survey of Current Business*, under the heading of "Business Situation".

US inflation: Calculated from seasonally-adjusted level of CPI, as published by US Bureau of Labor Statistics.

Federal funds rate: Federal Reserve Board.

Euro-area inflation and overnight lending rate: ECB. Inflation calculated from seasonally-adjusted level of harmonized index of consumer prices.

Euro-area real GDP, most recent data: Annualized version of quarter-on-quarter rates of change (seasonally adjusted), as obtained from ECB. Data cover Greece for entire sample period.

Euro-area real GDP, original data: Obtained from ECB, *Monthly Bulletin*. For much of the sample period, the ECB did not publish quarter-on-quarter rates of change in real GDP. Instead, I calculated the rates of change from the quarterly levels of real GDP, as initially published, and from the previous quarter's levels, as published in the same issue of the *Monthly Bulletin*. The data on the level of real GDP for the sub period 1997:3 to 1998:3 are taken from the first (January 1999) issue of the *Monthly Bulletin*. There is a jump in the data from 2000:4 to 2001:1 upon the accession of Greece to the euro system. For this reason, I determined the growth rate for 2001:1 by linear interpolation.

Figure 1: Reaction of US Federal Funds Rate of Interest to Inflation and Real GDP Growth

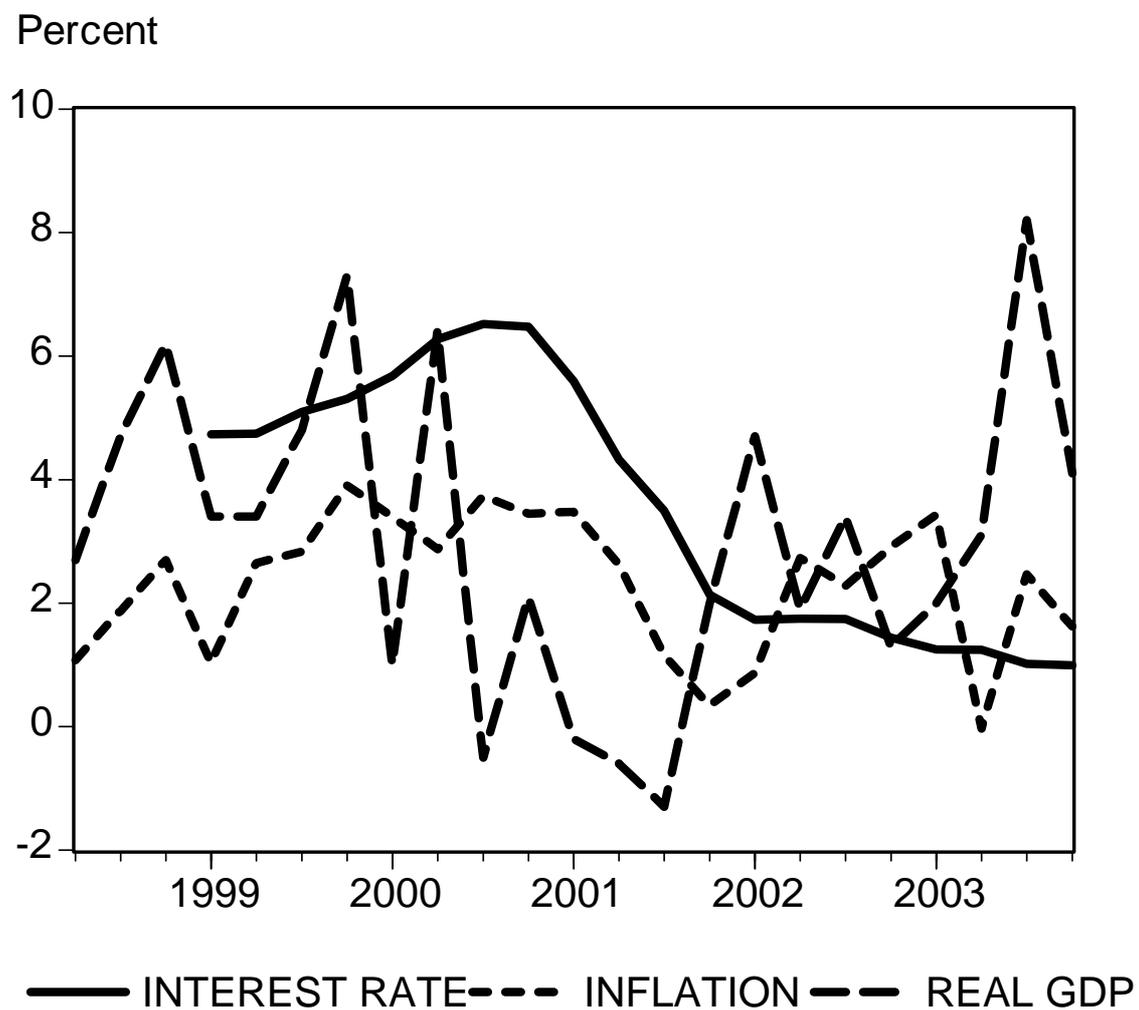


Figure 2: Reaction of Euro-Area Overnight Lending Rate of Interest to Inflation and Real GDP Growth

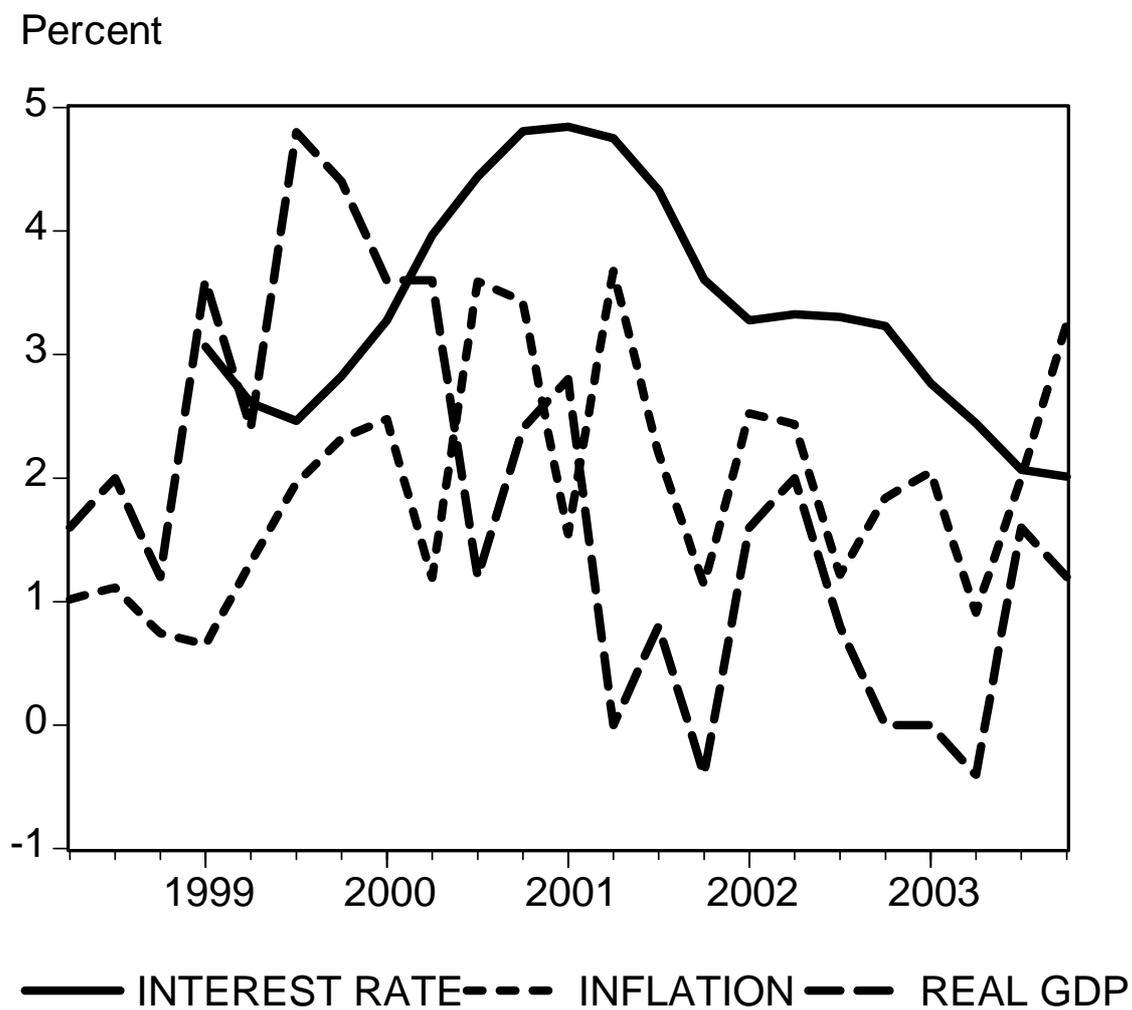


Figure 3: Revisions in Data on US Real GDP