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A Qualitative and Quantitative Analysis

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ABSTRACT :

This paper analyses the European Central Bank (ECB) monetary policy over the period 1999-2005, both from a qualitative and a quantitative perspective, and compares it with the Federal Reserve Bank. The qualitative approach builds on information conveyed by various speeches of the central bank officers, mainly the President of the ECB, Jean-Claude Trichet. The quantitative analysis provides several estimates of what could have been the ECB and Fed interest rate rules. It also develops a VAR model of both the Euro zone and the US economy so as to analyze dynamic effects of an interest rate shock. Both the qualitative and quantitative analyses point to the difficult task of the ECB, which must build credibility while managing monetary policy under major uncertainty about the structure of the new Euro area. They also suggest that, apart from the ECB's credibility building, differences between the observed behaviour of the ECB and the Fed over the time period under investigation should be accounted for by differences in the economic outlook of the two areas, rather than in the goals of the central bankers.

Key-Words:

- ECB and Fed
- Euro area
- Monetary policy
- Taylor rule
- VAR

RESUME :

Cet article étudie la politique monétaire de la BCE sur la période 1999-2005 en s'appuyant sur une analyse qualitative basée sur l'interprétation des messages du Président de la banque centrale ainsi qu'une analyse empirique des principales décisions. Cette dernière analyse propose plusieurs estimations de la règle de Taylor de la BCE et développe un modèle vectoriel autorégressif de la zone euro, afin d'étudier l'impact des chocs du taux d'intérêt. Ces résultats sont mis en perspective avec la politique monétaire de la Fed.

Mots-clés :

- BCE et Fed
- Politique monétaire
- Règle de Taylor
- VAR
- Zone euro

JEL Classification : E52, E58, F01

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Abstract

This paper analyses the European Central Bank (ECB) monetary policy over the period 1999-2005, both from a qualitative and a quantitative perspective, and compares it with the Federal Reserve Bank. The qualitative approach builds on information conveyed by various speeches of the central bank officers, mainly the President of the ECB, Jean-Claude Trichet. The quantitative analysis provides several estimates of what could have been the ECB and Fed interest rate rules. It also develops a VAR model of both the Euro zone and the US economy so as to analyze dynamic effects of an interest rate shock. Both the qualitative and quantitative analyses point to the difficult task of the ECB, which must build credibility while managing monetary policy under major uncertainty about the structure of the new Euro area. They also suggest that, apart from the ECB's credibility building, differences between the observed behavior of the ECB and the Fed over the time period under investigation should be accounted for by differences in the economic outlook of the two areas, rather than in the goals of the central bankers.

Keywords : Monetary policy, ECB and Fed, euro area, VAR, Taylor rule
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1. Introduction

Economists often resort to linear models of the interest rate determination, the so-called Taylor rule, to describe the essentials of a central bank's monetary policy. Yet, in day-to-day decision making, central bankers follow a rather pragmatic approach in formulating their policy decisions. They take into consideration a variety of variables and even "hunches" that are not necessarily captured by simple rules.

The main purpose of this paper is to try to unveil the ECB decision-making process, building upon both a qualitative analysis and an empirical analysis of its main monetary policy decisions. A comparison with the Federal Reserve Bank is also conducted so as to shed some light on the differences, and similarities, in both decision processes. The qualitative analysis is conducted by studying the public statements and positions (press conferences and speeches) given by the President of the ECB, Jean-Claude Trichet, in name of the Governing Council of the central bank.

The quantitative analysis aims to extract from the data the basic responses of the ECB to main macroeconomic variables, and compares the empirical results with principles revealed by the qualitative analysis. First, we estimate several variants of the ECB and the Fed interest rate rules. The second approach is more closely related to the qualitative analysis: it builds a VAR model of the euro area and of the United States economy, so as to try to unveil the impact of an interest rate change on main macroeconomic indicators.

By putting together both the quantitative and the qualitative analysis one may get a good picture of the ECB monetary policy, with special emphasis on the Trichet presidency years, and draw interesting comparisons with the Fed's.

2. Objectives and instruments of the ECB monetary policy

The background of monetary policy in Europe comes from the Maastricht Treaty whereby the ECB must mainly insure price stability but must also accompany the economic situation of the euro zone: "… the primary objective of the ESCB shall be to maintain price stability. Without prejudice to the objective of price stability, it shall support the general economic policies in the Community…"[1]

[1] *Maastricht Treaty, Treaty on European Union*, Maastricht, 7 February 1992.

Price stability has been defined by the Central bank as "a year-on-year increase in the Harmonised Index of Consumer Prices (HICP) for the euro area of below 2%." In May 2003, the Governing Council of the ECB has clarified the objective of price stability as maintaining the inflation rate (measured by the rate of growth of the HICP) below, but close to, 2% over the medium term.

To serve this objective, the ECB builds on two analytical perspectives, referred to as the "two pillars": economic analysis and monetary analysis. These two perspectives are the basis for the Governing Council's overall assessment of the risks to price stability and monetary policy decisions. Economic analysis consists of the analysis of economic dynamics and shocks to the euro zone economy, whereas monetary analysis is mainly concerned by money and credit growth trends.

The strategy also includes a framework "for explaining monetary policy decisions to the public in a clear and transparent manner. In this respect, a high degree of transparency does not only help the central bank to carry out its mandate more effectively, but also to ensure accountability to the public."[2] This communication role is often emphasized by J.C. Trichet and appears to constitute an important factor of the ECB policy.

Open market operations are the main instrument of monetary policy.[3] They play the most important role in steering interest rates, managing the liquidity situation and signalling the monetary policy stance. These operations are initiated by the ECB which decides on the means and on their terms and conditions (essentially interest rates and quantitative limits).

Minimum reserves are also part of the framework for the monetary policy in the euro area. The aims of minimum reserves are to help stabilise money market interest rates and "possibly contribute to the control of monetary expansion."

3. European monetary policy in action

Here our purpose is to explicit the different variables that enter the determination of monetary policy as can be deducted from the official statements of the policy maker, mainly

[2] *ECB Strategy*, ECB website, www.ecb.int/info/strategy.

[3] See for more details on this: ECB (2001); Ayuso and Repullo, (2003); Fourçans and Vranceanu, (2004).

from the President of the central bank, over the most recent period.[4] With this perspective in mind, we must analyse the role played by the following variables:

1. the inflation rate and the expectations thereof;
2. the price of imported goods, and the impact of two main variables affecting it: the price of oil and the euro-dollar exchange rate;
3. the evolution of the monetary aggregates (money and credit growth);
4. the state of the real economy as represented by its rate of growth (or of unemployment) and the expectations thereof;
5. the evolution of wages and of other significant variables such as productivity, asset prices, budget deficits and different structural factors.

3.1. The role of inflation and inflationary expectations

No doubt, inflation and inflationary expectations are the core variables influencing practical monetary policy choices in the euro zone. A typical sentence: "It is of the essence (of monetary policy) that the increase in the current inflation rate does not translate into inflationary pressures over the medium term and to ensure that inflation expectations remain firmly anchored at levels consistent with price stability."

At the time of this statement (November 2005) the inflation rate was above 2% (annual estimate of 2.5% in October 2005, 2.6% in September and 2.2% the two preceding months), significantly higher than the "below 2% but close to this value" target, and the expectation was for it to remain high in the short term. Yet it is clear that the policy maker draws a distinction between the short-term inflation rate, i.e., a once and for all increase in the general level of prices, and the expected long-term value of inflation. It is the latter that the ECB announces to take into consideration by making assessment of "forward-looking price developments." How these expectations of price developments are formed is not explicitly developed, yet there are different variables that influence the policy maker's long-run price expectations.

The price of import goods appears to be one of the important variables taken into consideration in forming inflationary expectations. By the end of 2005 the price of oil is of

[4] The references are essentially the *Press Conferences* given by J.C. Trichet after each meeting of the Governing Council over the year 2005 or so, and the *Reports to the European Parliament.* When other references are used, they are explicitly mentioned.

course the overriding factor in this respect. Other times, such as during the second semester of 2002 when the euro appreciated dramatically, it is the euro-dollar exchange rate. It must be noticed that our policy maker, at least in his explanation of policy, takes into consideration the direct effect of this type of external shocks but also the possible pass-through "via the domestic production chain, and (via) potential second-round effects in wage and price setting behavior." Uncertainties surrounding oil market developments are therefore watched, not only in the short run but also in the future months. The same can be said about the value of the euro on the foreign exchange market.

Inflationary expectations also depend on "the second pillar" of monetary policy, that is monetary developments: "We (Mr. Trichet) believe that in the long run inflation is a monetary phenomenon."[5] One cannot be clearer.

In the first years of the European Monetary Union (EMU) money growth was explicitly considered as a "reference value" (of 4.5% a year) in the conduct of monetary policy. This explicit reference value was eliminated in 2003 but the growth of the M3 monetary aggregate still appears to be a variable taken into consideration by the policy maker. In his November 3rd, 2005 Press Conference the President of the ECB estimated that "monetary analysis … points to increase upside risks to price stability over the medium to longer term", based on the "strengthening of monetary growth observed since mid-2004 (that) has gained momentum over the past few months." The low level of interest rates is, in Mr. Trichet's words, the dominant factor explaining this acceleration in money (and credit) growth.

3.2. The role of growth and unemployment

The role of real growth and unemployment in monetary policy decisions is less clear and less clearly explained by our policy maker. It does not mean that he does not take it into consideration, but that it comes second in terms of priority, after price developments. And the role of economic slack, or on the contrary of over-heating, may be taken into consideration primarily because it may have an impact on prices rather than because of its value *per se*, at least in the short run. And furthermore, as members of the Governing Council, at least in his official voice if not on the individual level perhaps, share the view that growth (and

[5] Jean-Claude Trichet, *Interview* with the Irish Time, Le Figaro, El Mundo and Frankfurter Allgemeine Zeitung, 21 September, 2005.

unemployment) are favourably affected by price stability, the price stability objective overrides the short term rate of real growth (or of unemployment) in the determination of monetary policy. As explicitly stated on the ECB web site[6], "it is widely agreed that in the long run… a change in the quantity of money in the economy will be reflected in a change in the general level of prices. But it will not induce permanent changes in real variables such as real output or unemployment." And it stresses the point by adding that "a central bank can only contribute to raising the growth potential of the economy by maintaining an environment of stable prices. It cannot enhance economic growth by expanding the money supply…"[7]

Another issue raised by J.C. Trichet concerns the role that the growth potential and the output gap should play in terms of monetary policy: the reliability of these measures. "We have to be humble in front of facts and figures. We are very cautious when monitoring the twin concepts of growth potential and output gap. Experience has demonstrated that that they could be dramatically revised over time."[8] Then, a central bank overly influenced by such indicators would lead to an erratic policy process that would be detrimental to stability and growth. This is another sign that one must be careful in interpreting the role of these real variables in the decision making process.

Finally, as we will see below, the ECB shares the view that long run growth and unemployment do not depend on monetary policy but on structural factors of the economy, another reason to be careful in the use of growth (or output gap, or unemployment) statistics in the conduct of monetary policy – and another reason to be careful about the interpretation one can make with respect to the role of these variables in the monetary policy decision making process.

3.3. The impact of wages, fiscal policies and structural factors

The evolution of wages is looked at insofar as it can be a vector of inflation transmission over the economy. These "secondary effects", taken as the "main enemy" by the central banker are watched with "extreme care" in order to avoid the spread of inflationary

[6] See www.ecb.int/mopo/intro/html/role.en.html.

[7] Jean-Claude Trichet can also be called upon: "… price stability (is) a necessary condition for sustainable growth and job creation: the central bank is called upon to deliver price stability … thereby contributing to maximizing sustainable growth", in *"Key Issues for Monetary Policy: an ECB View"*, National Association of Business Economics, Philadelphia, 5 October, 2004.

[8] Jean-Claude Trichet, *Interview*, op. cit.

pressure, especially in periods of external shocks such as an oil shock or an exchange rate shock.

Too lenient fiscal policies are also the *bête noire* of J.C. Trichet. Excessive deficits are "a matter of great concern" and too much lightness in implementing the Stability and Growth Pact is seen as undermining the credibility of the Pact and thus long term prospects of growth and unemployment. It is interesting to notice that the decision maker does not appear to pay special attention to the upward pressure on interest rates that budget deficits may induce, and consequently the pressure on monetary policy that may result. He prefers to emphasize its "direct" impact on growth and employment, probably to counter criticism that monetary policy in itself could slow down growth.

As far as structural reforms are concerned, the ECB insists on "the urgent need to increase the flexibility of labor and product markets" so as to better capture "the opportunities arising from globalization and rapid technological change", rather than on the way they can influence monetary policy. Labor costs are also considered, and in some cases "it could be good to have nominal wages and salaries moving more slowly than the labor productivity increases", but they are seen more in terms of their impact on competitiveness and employment than in terms of their monetary policy impact. Productivity *per se* does not seem either to be taken into consideration in the conduct of monetary policy, even though boosting labor productivity growth must be "another central component … to enhance Europe's growth potential."

As to asset prices, the Governing Council "is monitoring closely what happens" and they must be "looked at very closely." But that does not mean that these variables impact directly the monetary policy process, they just enter the analysis through the two pillars strategy. And they may have an important informative role as to the evolution of inflationary expectations (through, for example, the measure of the break-even inflation rate), the assessment of these expectations playing a central role in the conduct of monetary policy.

4. The art of central banking: the ECB case

Central banking is an "art" as well as a "science".[9] The policy maker must of course take into consideration the economic facts and have a "model" of the economy in the

[9] On the "science" matter, it is interesting to notice that in a speech more "academic" than the usual ones, J.C. Trichet makes explicit reference and pays special tribute to the macroeconomic "stars" of our profession, Lucas,

background (be it explicit or implicit, structured or informal) to take and implement decisions. But it must also deal with more fuzzy variables and concepts such as credibility, transparency, market reactions, fundamentals and short-run versus long-run horizons. Where does the ECB stand on these matters and how do they influence its decision making process?

The European central banking process appears to focus on two main issues: anchoring long-run inflationary expectations and building the credibility of the central bank on this matter. "Anchoring inflation expectations is not only important for low medium and long-term market interest rates. It is also crucial for reducing macroeconomic fluctuations in response to economic shocks."[10] And this anchoring of inflationary expectations is best achieved, in the central banker's views, through an explicitly defined and credible price stability objective. And this stability objective is reached through the two-pillar approach of monetary policy (the economic and the monetary pillars). The loop is closed.

Building credibility is not an easy matter, especially for a young central bank. Hence the strong and repeated statements of Mr. Trichet that monetary policy should not be too sensitive to short run shocks to the economy, except if they may affect long-run expectations or economic variables, but should rather be geared towards the fundamentals, and their expected changes: "…it pays to adopt a systematic policy focused on responding to the fundamental forces at work in the economy in a predictable manner, disregarding the vagaries of expectations and markets."[11] If the President of the ECB acknowledges that expectations instability may imply a more "aggressive" monetary policy, i.e., more variability in the interest rate, to stabilize these expectations, he immediately adds that this type of reaction would be unnecessary "in many circumstances" as long as the central bank has a clear price stability objective and does not pretend to fine-tune the economy. Hence the emphasis on credibility in maintaining inflation "at levels consistent with the price stability objective."

This core principle goes a long way in explaining why the European interest rate has moved much less than the US rate over the years (from 2001 to December 2005, the European Central Bank has changed its rate 7 times whereas the Fed has changed it 19 times. And from

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Sargent and Wallace, Barro, Gordon, Rogoff, Clarida, Orphanides, etc.: "*Monetary Policy and Private Expectations*", Zolotas Lecture, Bank of Greece, Athens, 25 February 2005.

[10] Jean-Claude Trichet, *" Monetary Policy in EMU, Views and Challenges "*, ZEW, Mannheim, 24 June, 2005.

[11] Jean-Claude Trichet, *" Monetary Policy and 'Credible Alertness' "*, Symposium sponsored by the Federal Reserve Bank of Kansas City, Jackson Hole, Wyoming, 27 August, 2005.

mid-2004 to the end of 2005, the Fed has raised its rate 12 times whereas the ECB… has not changed it at all since June 2003) (Figure 1).

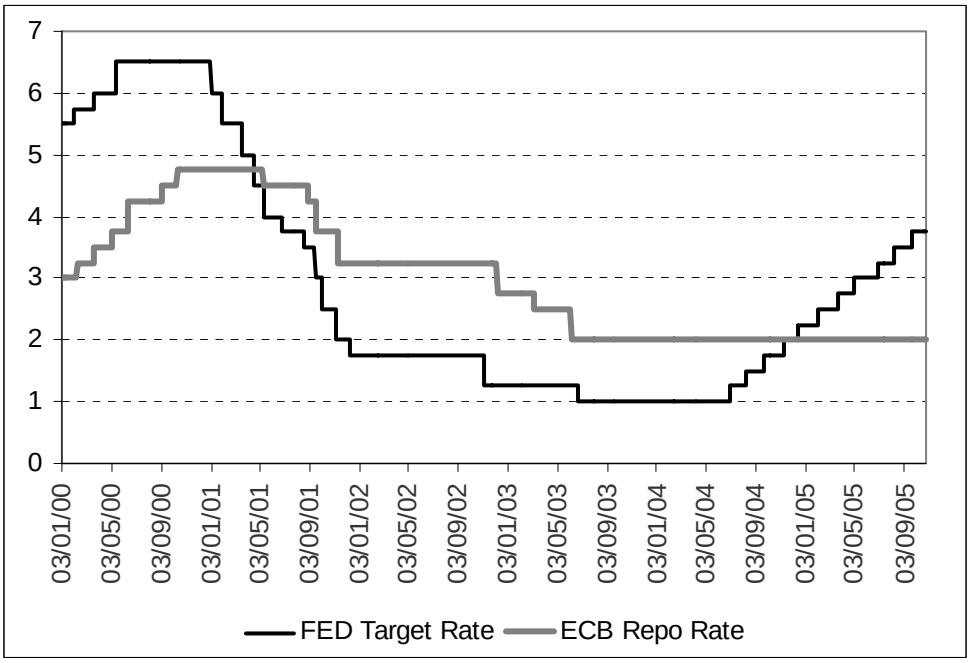

Figure 1: Fed and ECB main instrument rates

Certainly, as mentioned above, our central banker admits that there may be "a disconnection between private views about the macroeconomic outlook and the central bank's own internal forecast." [12] But an aggressive policy may not be the best way to treat this question. A "more optimal behavior consists in appropriately communicating the central bank's assessment of the fundamental state of the economy and its prospects in order to regain control of inflation expectations." [13] The crucial role given by the ECB to its communication strategy in the conduct of monetary policy is the consequence of this view.

Communication, "an integral part of monetary policy…as it contributes considerably to the efficiency of its policies"[14], is important in two ways: 1) verbal reminder and active demonstration that the Bank follows a consistent rule of policy along the lines of the price stability objective and the two pillar strategy; and 2) explaining its views on the economy so as to drive as much as possible market expectations without necessarily "engineering policy

[12] Jean-Claude Trichet, *" Monetary Policy and 'Credible Alertness' "*, op. cit.

[13] Jean-Claude Trichet, *" Monetary Policy and 'Credible Alertness' "*, op. cit.

[14] Jean-Claude Trichet, *" Communication, Transparency and the ECB's Monetary Policy "*, The International Club of Frankfurt Economic Journalists, Frankfurt, 24 January, 2005.

actions", that is, without changing the interest rate. In so doing, the European central banker considers that he can have inflation expectations converge towards their long-run value driven by the fundamentals of monetary policy.

Short-run macroeconomic shocks should not make the Governing Council change its views on this matter. Consistency on this type of policy is more important, for the Council, than over-reacting to economic fluctuations and to the business cycle. Credibility must stem more from this policy process than by changes in the interest rate. Hence the repeated position of the ECB that it does not pre-announce a change in the interest rate, be it an increase or a decrease, that it does not "promise anything in advance" on that respect. But that it will act, and "the markets must know that", and move the rate if there is a need to move so as to stabilise inflation expectations. It is the credibility in stabilising these expectations and the "vigilance" of the central bank on the matter that is the fundamental clue, whatever the means used to achieve that goal may end up being.

As can be seen, communication, and the transparency that goes with it, is a central variable of the art of monetary policy as practiced by the ECB. That explains the regular press conferences given by the President of the Bank just after the first Governing Council meeting of each month, the immediate publication of an explanation of the decision taken by the Governing Council (but without revealing the individual standings of each national central bankers and members of the board, the Bank refuses to do that), the Monthly Bulletin always published one week after the press conference, the testimonies and Reports to the European Parliament and the various speeches of the President and other members of the Governing Council (the positions taken in all of these speeches are so similar that they surely are well "coordinated"…).

In this respect, one may notice a change in the ECB's communication strategy which seems to have taken place after Jean-Claude Trichet took office. Compared with the Duisenberg Presidency, when top-officials of the ECB used to communicate their personal view on economic outlook or desirable policy, Mr Trichet seems to have imposed more discretion; he appears to be the only person in charge of official external communication. This move may be welcome by the financial markets which dislike contradicting in formations.

5. The ECB and the Fed: different paradigms?

In evaluating this type of question two issues must be dealt with: the mandates of both institutions and the way they conduct their respective monetary policies.

5.1. The mandates of the two Banks

The mandates of the two central banks differ, at least in their explicit formulation. We saw in Section 2 that the objective of the ECB is *mainly* to maintain price stability but also to support the general economic policies of the European community. A 1977 amendment to the Federal Reserve Act states that the U.S. central bank is to promote "maximum employment, stable prices and moderate long-term interest rates", i.e., a somewhat broader mandate than the ECB's. If we go beyond the words, the ECB mandate is more explicitly mandated to achieve price stability (a close but below 2% inflation rate) than the Fed's – which, furthermore, does not have, at least currently (fall of 2005), an explicit inflation target. Yet both central banks must take into consideration the state of the real economy (output and unemployment) even though, in this respect, the Fed's mandate is more explicit than that of the ECB.

Do these mandates explain the difference in policy making by the two central banks? Probably not, at least not in a significant way. The differences appear to stem more from different ways of analysing the monetary policy background, and from the respective history of each of these Banks.

5.2. Two distinct approaches to monetary policy: the credibility variable

At the outset it must be said that both central bankers hold the same view about the role of money in the economy, that is, they follow the mainstream view among academic economists and central bankers. This view can be summarised as:

1. money is neutral in the long-run, even though it can have short-run potentially destabilizing effects on output and employment;
2. in the long-run inflation is a monetary phenomenon, but other shocks may in the short-run affect the general level of prices (variations in aggregate demand, technological changes, fiscal policy, import prices, etc.);
3. price stability is a condition for a lasting high level of growth.

In spite of sharing the same theoretical background, the implementation of monetary policy has been somewhat different between the two Banks, especially in terms of the variability of the interest rate, and the speed at which the rate is changed. As seen in Section 4, the Fed has changed its target rate significantly more often than the ECB has. On that respect,

the degree of activism of the US central bank appears to be significantly higher than the European central bank's.

How to explain this difference in monetary policy implementation?

The main and overriding factor rests upon the *credibility* factor associated with the art of central banking, and the conditions under which this credibility is built. Given the price stability objective, both central banks seek to stabilize inflation expectations so as to avoid as much as possible real economic disturbances, i.e., variability in output and employment. The more credible a central bank is in reaching its price stability objective, the more credible it is in stabilizing expectations. The building of this credibility, and of maintaining it over time, is of paramount importance in the conduct of monetary policy, especially for the still "young" ECB.

Both Banks have somewhat different means of insuring credibility. The Fed, a well established central bank, has developed over the last two decades or so a high degree of credibility in terms of maintaining inflation at low levels. The ECB started its function only in 1999, too short a time period to establish its credibility in a lasting way. Hence the Fed can take a more activist role than the ECB in its manipulation of the interest rate without putting its credibility with respect to fighting inflation in jeopardy. The European central banker has less freedom on that matter. He considers that he must demonstrate a greater explicit commitment to maintaining price stability, this demonstration resting, at least in part, on his being less prone to deviate from this objective even in the short-run and therefore on being less of an activist in terms of changes in interest rate. He also considers that the anchoring of inflation expectations can be reached by other means than by changes in the interest rate:

> "… whilst the central bank must always be ready to take aggressive action if needed, a well-designed institutional framework, which undisputedly assigns the central bank the primary objective of price stability, and the adoption of a clear monetary policy strategy, which quantitatively defines price stability and do not pretend to fine-tune directly the business cycle, can make the latter type of policy activism [the manipulation of the interest rate] unnecessary in many circumstances. The reason is that this framework reduces uncertainty about the central bank's ultimate motives, provides a stronger anchor for inflation expectations and makes it easier for the market to map the expected path of the policy rate to the evolution of macroeconomic conditions. This would reduce the likelihood that expectations might over-

react in the first place and, should expectations instability nevertheless occur, provides the central bank with an additional viable option[15]."

And Trichet to add:

"… under some conditions the central bank can regain control of private expectations without necessarily changing interest rates, but by being visibly and credibly alert, explaining and stressing its commitment to maintaining inflation at levels consistent with the price stability objective[16]."

This credibility question goes a long way in explaining the behavior of the ECB compared to the Fed's. For the ECB credibility is built through the institutional framework with a strong commitment to price stability and the "right" communication strategy. Hence the great importance it gives to transparency through:

1. The announced inflation objective, contrary to the Fed which does not have (yet?) such an explicit objective.
2. The explicit and detailed cross-check between its economic analysis and its monetary analysis, the latter being considered central to better anchor inflation expectations since the Bank "cannot rely, for that purpose, on long-term past records[17]." The monetary analysis is also important to avoid "boom-bust episodes in asset prices which could be fed by abnormal abundance or drying up of liquidity[18]." If the Fed presents equally a comprehensive analysis it is less didactic as to the way it analyses the economic and monetary background, and about the role each play in policy decision making, notably its monetary analysis.
3. The frequent information and "words" to the market by the President of the ECB that "the objective of the Bank is price stability", that "he does not promise anything else", that "he is free to conduct policy without political influence" or "false signals" that may come from the market, that his "policy is

[15] Jean-Claude Trichet, " *Monetary Policy and 'Credible Alertness*' ", op.cit.

[16] Jean-Claude Trichet, op.cit.

[17] Jean-Claude Trichet, *" Issues in Monetary Policy: views from the ECB"*, the Economic Club of New York, New York, 26 April, 2004.

[18] Jean-Claude Trichet,*" Issues in Monetary Policy: views from the ECB"*, op.cit.

medium and long-run oriented", in other words that he is "vigilant" about inflation expectations and their stability. If the Fed also emphasizes transparency, it insists less on these factors in its communication, probably judging that it does not have to prove its credibility, the *personal* credibility of its Chairman (at least under Mr. Greenspan) being enough. Mr Trichet relies more on *institutional* credibility than on personal credibility.

Another reason for the difference in communication policy may also result from the different state of development of the financial markets of the two monetary zones. The U.S. financial markets are deeper, wider and more integrated than in Europe, which makes the former more reactive to change in interest rates than the latter. Another factor of differentiation may also result from the fact that the Federal Reserve is a national central bank whereas the European central bank is a multinational one, though it is difficult to say to what extent this may influence the conduct of monetary policy.

6. The ECB interest rate rule: concept and previous estimates

A quantitative analysis is important to complete the qualitative study and to examine whether or not the facts support the latter.

The systematic behaviour of a central banker may be analyzed by inferring from the data an empirical monetary policy rule. Such a rule describes the relationship between the main central bank instrument -- in general, the target short-term interest rate -- and relevant economic independent variables.[19]

Denoting by $E[-]$ the expectation operator and by I_t the information set at the time the interest rate is chosen (i.e., at time t), such a policy rule takes the form:

$$i_t^* = \bar{i} + \beta(E[\pi_{t+k}|I_t] - \bar{\pi}) + \gamma E[y_{t+q}|I_t] + AE[\Theta_{t+\ell}|I_t] \qquad (1)$$

[19] The pioneer of these rules was John Taylor (Taylor, 1993). Svensson (1999) distinguishes between an explicit instrument rule, where the instrument is related to predetermined variables only and an implicit instrument rule, where the instrument comes out as a function of forward looking variables.

where i_t^* stands for the *target* interest rate, π_{t+k} is the inflation rate *k* periods ahead, $\bar{\pi}$ is the target inflation rate, y_{t+q} is the output gap *q* periods ahead; Θ is a vector of variables other than inflation and the output gap (at time $t+\ell$) and *A* is the respective vector of coefficients. $\bar{i}$ can be interpreted as the desired (target) nominal interest rate, to be obtained when both inflation and output are at their target level. β and γ are given parameters. In so called "contemporaneous" rules, *k*, *q* and *l* are set to zero; in "forward looking rules", some of them are positive.[20]

The important role played by the β coefficient on the stability of the macroeconomic system have often been pointed to (inter alia, Kerr and King, 1996; Bernanke and Woodford, 1997; Clarida et al., 2000). These studies are based on simple macroeconomic dynamic models, with three main equations: an IS curve, linking the output gap to real interest rates; a Phillips curve, whereby the inflation rate is positively related to the output gap; and a monetary policy rule. When a shock pushes inflation above the target, the central bank increases its interest rate according to the policy rule. If $\beta<1$, the increase is not strong enough to bring about a higher real interest rate, demand is stimulated, and, *via* the Phillips curve mechanism, inflation is further enhanced. On the other hand, if $\beta>1$, the strong response of the central bank brings about an increase in the real interest rate, which tempers demand and inflation.

The fact that the ECB has such a short history makes difficult but not impossible econometric estimations of an interest rate rule. Table 1 below summarizes the findings of several researches. All point out to the sensitivity of the ECB to real activity: if the current output goes below its trend (or the output growth rate falls below the target), the Bank will reduce interest rates and vice-versa.

In most of these studies, the ECB increases interest rates if the inflation rate exceeds the 2% target, yet it is not clear whether the Bank's action is stabilizing or not; some economists found that the β coefficient is bigger then one, whereas some studies found a β lower than one. As far as the Fed is concerned, all studies made in the nineties find that the American central bank reacts energetically to excessive inflation (β is larger than one).

[20] It must be emphasized that these simple linear estimates might not allow to infer the ultimate goal of the Central Banker. As Svensson (1997, 1998) has shown, a linear reaction function, including on the right hand side other variables than contemporaneous inflation (output gap, exchange rate) may be characteristic of a forward looking policymaker concerned with inflation only; it may be consistent as well with a policymaker concerned with both price and output stability.

Study	Type of rule	Freq.	Period	β	γ	Obs.
Gerdesmeyer & Roffia, 2003	Contemporaneous	M	99.01-02.01	0.45	0.30	
Ullrich, 2003	Contemporaneous	M	99.01-02.08	0.25	0.63	0.08 coefficient of the real ex. rate
Fourçans & Vranceanu, 2004	Contemporaneous	M	99.04-03.10	0.43	0.26	0.08 coefficient on the nominal exchange rate
	Forward (+6)	M	99.01-03.10	2.8	0.19	
Surico, 2003	Contemporaneous	M	97.07-02.10	0.58	0.60	Quadratic term in inflation
	Forward (+3)	M	97.07-02.10	0.85	0.60	Quadratic term in inflation
Sauer & Sturm, 2003	Contemporaneous	M	99.01-03.03	0.51	0.37	OLS ex-post
	Forward (+3)	M	99.01-03.03	0.86	0.86	GMM ex-post
	Forward (+3)	M	99.01-03.03	2.14	1.84	GMM real time
Belke et al. 2005	Contemporaneous	Q	99.1-05.4	0.49	1.94	
Fendel & Frenkel, 2006	Forward (+12)	M	99.1-02.12	2.54	1.43	Quadratic trend in industrial output
	Forward (+12)	M	99.1-02.12	1.69	0.29	Linear trend in industrial output

Table 1. A review of main Taylor rules estimates for the ECB

In the research by Ullrich (2003) the ECB appears to react to real appreciation of the euro by lowering its interest rate, as if it would aim to offset the negative effect on exports by stimulating consumption and investment; this response implies that the real activity goal of the Bank is more important than indicated by the coefficient on the output gap alone. In our former research (Fourçans and Vranceanu, 2004), a nominal appreciation of the euro prompts the ECB to reduce its interest rate; this suggests that the Bank takes into account the depressing impact on prices that a nominal appreciation may entail, and accommodates its monetary policy accordingly. Most empirical studies on the ECB show that, despites its verbal commitment to the former money stock growth "reference value" (4.5% a year) the Bank seems to pays little attention to this indicator, at least directly (Fourçans and Vranceanu, 2004; Fendel and Frenkel, 2006).

A comparison of these studies puts forward an important result: the coefficient of the inflation variable (β) is much bigger in forward-looking rules than in contemporaneous interest rate rules. Moreover, in the estimates of contemporaneous rules, variables other than inflation are significant. This result is logical. If the policymaker is concerned about future inflation, contemporaneous inflation and other variables that have a bearing on future inflation must be significant. Yet in estimates of a forward looking policy rule, the most consistent with the goal of maintaining price stability *in the medium run*, the impact of the variables having

an impact on inflation must be captured by the coefficient of future inflation (which itself serves as a proxy for expected inflation). If the output gap (or another real activity measure) is significant in forward looking interest rate rules, together with future inflation, this might suggest that the bank has a direct concern about real activity.

7. A comparison of the ECB and Fed interest rate rules over the interval 2000 – 2005.

In this section we carry out new estimates of the ECB and Fed interest rate rules over the interval 1999.01 to 2005.10. Data are monthly.[21] The dependent variable is a relevant measure of the target short-term interest rate (**INTRA**). For the ECB, we test the model with the annualized ECB minimum bid rate over short-term reverse-repo operations, in percent, such as recorded at the end of the month.[22] For the Fed, INTRA corresponds to the Federal Funds Target Rate.

The main exogenous variables are: **INF**, the inflation rate, calculated as the yearly percentage change of the representative price index from one month to the same month of the previous year and **IPDEV**, the deviation of the industrial output growth rate from the over-the-period average (of 1.5% for the Euro-area and 1.7% for the US); the growth rate is calculated as the percentage change of the industrial output index from one month to the same month of the previous year.

In its most elementary variant, the interest rate rule takes the form:

$$INTRA_t = C + c_1 INF_t + c_2 IPDEV_t + \varepsilon_t$$

where ε_t is an i.i.d error term and C is a constant. Table 2 shows the coefficients estimated by OLS, for the ECB and the Fed (1999.01 to 2005.10):

	ECB rule	**Fed rule**
C	1.62	0.16
INF	**0.66*** **	**1.17*** **
IPDEV	**0.13*** **	**0.12** **
Nb obs	80	80
R^2-adj	0.16	0.27
DW	0.09	0.08

[21] All series come from *Thomson Datastream*.

[22] Tests carried out with the monthly average of EONIA, the overnight interest rate, lead to almost similar results.

*** significant at 1%, ** significant at 5%,

Table 2

This is clearly a poor representation of the interest rate rule followed by both banks ; though, it has the merit of pointing that a) as indicated by the R^2-adj. statistics, important variables are probably omitted, b) that their role is probably more important for the ECB than for the Fed, c) that in this elementary framework, both banks have the same stance with respect to the industrial output growth gap, and that d) the Fed seems to be much more aggressive in terms of responses to inflation (the coefficient of inflation is a rough estimate of β).

The former elementary model includes inflation recorded at date *t*. Generally, observers consider that at least nine months must pass before the first effects of a change in monetary policy on inflation are noticeable. In order to improve the fit of the model and also get a more realistic description, we test for the significance of leads of inflation, seen as proxies for inflation expectations.

It has also been argued that central bankers may be concerned by the fact that overly abrupt changes in interest rates may disrupt bond and equity markets. If this is so, the policymaker would smooth changes in interest rates such as to reach the *target* i_t* after a more or less lengthy period. The *effective* interest rate chosen by the central bank, i_t, would follow a law of motion: $i_t = \Gamma(L) i_{t-1} + (1-\rho) i_t^*$, where $\Gamma(L) = \rho_1 + \rho_2 L + ... + \rho_n L^{n-1}$ is a lag-polynomial; dynamic stability imposes $\rho = \sum_{j=1}^{n} \rho_j$ <1. Most often, empirical studies build on the most elementary version, according to which the effective interest rate that the central bank chooses at time *t* is a weighted average of the target rate and of the interest rate prevailing in the previous period: $i_t = \rho i_{t-1} + (1-\rho) i_t^*$, with $\rho \in [0, 1[$. For $\rho =$ 0, the adjustment is instantaneous; the larger ρ, the slower is the adjustment. The former equation is equivalent to: $i_t - i_{t-1} = (1-\rho)(i_t^* - i_{t-1})$, that is, within the interval (quarter or month, depending on the data frequency), the central bank will implement only (1-ρ) of the *desired change* in the interest rate.

The second empirical model becomes:

$$INTRA_t = c_1 + c_2 INTRA_{t-1} + c_3 INF_{t+k} + c_4 IPDEV_{t+q} + \varepsilon_t$$

where ε_t is an i.i.d composite error term that captures shocks and expectation errors. The regression coefficients relate to theoretical coefficients such as: $c_1 = (1-\rho)(\bar{i} - \beta\bar{\pi})$, $c_2=\rho$, $c_3=(1-\rho)\beta$, $c_4=(1-\rho)\gamma$.

All equations were estimated by the Generalized Method of Moments (GMM). As emphasized by Clarida et al. (2000), this method is well suited to econometric analysis of interest rate rules when the regressions build on variables that are not known by the policymaker at the time of decision making, the typical case for forward-looking Taylor rules where the policymaker makes decisions based on expected variables. Use of the Generalized Method of Moments requires specifying instrument variables belonging to the information set at time *t* and uncorrelated with the error term ε_t. The instruments used here are a two period lag of the dependent and independent variables, the lagged money growth rate and the actual and lagged stock market index (both should convey information about future prices).[23]

Table 3 below displays the main results. Variables are denoted by NAME(*n*), where *n* is the number of leads (or lags, for a negative number). We show a contemporaneous rule, (inflation is measured at time *t*), and forward looking rules (with a 9 and respectively 12-month inflation lead) for the ECB and the Fed.

	ECB Contempo+ raneous	ECB Forward 9-month	ECB Forward 12-month	Fed Contempo- raneous	Fed Forward 9-month	Fed Forward 12-month
C	0.070^{ns}	-0.339*	-0993***	0.191**	-0.372^{ns}	-0.257***
INTRA(-1)	0.935***	0.959***	0.953***	0.968***	0.968***	0.982***
INF	0.041^{ns}	---	---	-0.033^{ns}	---	---
INF(+9)	---	0.200**	---	---	0.17**	---
INF(+12)	---	---	0.523***	---	---	0.109***
IPDEV(-1)	0.07***	0.027***	0.007^{ns}	0.052***	0.013^{ns}	0.028***
Nr obs.	78	69	66	78	69	66
R2a	0.96	0.97	0.96	0.99	0.99	0.99
DW	1.85	2.22	1.70	1.95	2.2	2.18
J-stat	0.10	0.08	0.06	0.07	0.08	0.07

*** significant at 1%, ** significant at 5%, * significant at 10%

Table 3. Interest rate rule estimates for the ECB and the FED

The contemporaneous rules do not seem to be supported by the data neither for the ECB, nor for the Fed, notably as far as the coefficient on inflation is not significant. So we

[23] The GMM estimation was carried out with the *EViews* econometric software, under the option "heteroskedasticity and autocorrelation consistent covariance matrix". Full list of instruments: INTRA(-2), INF(-1), INF(-2), IPDEV(-2), MGR(-1), MGR(-2), STOCK, STOCK(-1), STOCK(-2).

focus hereafter on the forward-looking rules. With these rules, forward inflation and the output growth gap seem to be important determinants of each central bank's policy.

The next table displays the theoretical coefficients:

	ECB		Fed	
	9-month ahead forward rule	12-month ahead forward rule	9-month forward rule	12-month forward rule
β	4.88	11.1	5.15	6.12
γ	0.66	0.14	0.40	1.58
ρ in percentage change over the quarter	17%	20%	13.8%	7%

Table 4. Theoretical coefficients of the response function

When comparing the forward looking rules featuring the 9-month ahead inflation rate, the Fed and the ECB's behaviors seem similar. As shown by γ, the response of the central banker to the output growth gap is very close between the two regions. The reading of β shows that, in both areas, the response to inflation expectations seems strong, larger than shown by earlier estimates. This might not be very surprising, given that the years 2000-2005 were characterized by a difficult economic situation. Quite consistent with the credibility building developed earlier in this text, the ECB has a tough stance with respect to inflation deviations from the objective, comparable to the Fed. Over the period under scrutiny, both banks would raise the desired interest rate by one percentage point if the inflation forecast exceeds the target (explicit for the ECB, implicit for the Fed) by about $1/5^{th}$ percentage point. As far as the speed-of-adjustment parameter ρ is concerned, the ECB seems to adjust the interest rate more rapidly than the Fed; in quarterly terms, the Fed adjustment would be of 13.8% of the desired change, while the ECB's adjustment would reach 17%.

When the interest rate rules based on 12-month ahead inflation rates are considered, the ECB seems to be much more hawkish with respect to inflation and less concerned by real activity than the Fed is (in the ECB rule, the output growth gap is small and statistically non significant). Further research is needed to check whether this difference is substantive or is specific to the short time period under investigation.

8. A VAR analysis of the ECB and Fed monetary policy

The qualitative analysis emphasized that ECB decisions are made in a multi-dimensional environment, whereby many variables influence the policymaker decisions. In the former elementary model, inflation at time $t+n$ has been interpreted as a good proxy of the inflation forecast.

Yet one may try to work out a description of the euro zone economy so to analyze the dynamics induced by a change in the monetary policy instrument. Given the substantial uncertainty about the right theoretical model pertaining to the euro area, an unrestricted VAR model might be an interesting modeling alternative.

The VAR builds on the following variables: as in the previous analysis, ECBRA is the annualized ECB minimum bid rate over short-term reverse-repo operations, in percent, such as recorded at the end of the month, INFDEV is the deviation of the inflation rate from the 2% target, and IPDEV is the industrial output growth rate deviation from the 1.5% average. The other variables are FXDEV, the percentage of deviation of the euro per dollar exchange rate as compared to the period average of 0.95 euro/$,[24] and STOCK, the monthly average of a representative stock market index. Coefficients of the money stock growth rate were never found to be significant, so this variable has not been included in the final version.

The complete model is displayed in the Appendix. Equations must be interpreted very cautiously, given the limited number of observations. We choose a lag of three in compliance with Akaike information criterion. The inverse roots of the AR characteristic polynomial are all in within the unit circle: the system is stable.

Figure 2 shows the evolution of the main variables following an increase in the interest rate by one percentage point (basic impulse functions). In all four graphs, the horizontal axis represents the time elapsed after the shock (up to 18 months). The vertical axis measures variations in the variables.

As expected, the output growth gap declines (for about nine months and increases again afterwards), and so does the stock market index (falls by five percentage points over five months). Inflation increases in the very short run, and starts declining after a few months, to fall below the initial level after 15 months. The short run ‘inflation overshooting’ appears to be the first round effect of a euro depreciation related to the declining output growth.

[24] Given our definition of the exchange rate (euros per dollar), a positive FXDEV is tantamount to a “weak” euro and a mirror “strong” dollar, and vice-versa.

According to this elementary model, the impact on inflation over 18 months is rather small. This is consistent with the former analysis of the Taylor rule suggesting that the ECB seems to react strongly to an (expected) inflation deviation from its target. Such a strong reaction is justified by the shy response of the euro area inflation to interest rate changes, at least over a period of about one to one and a half years.

The analysis of the impulse functions in Figure 2 also points out the large uncertainty surrounding monetary policy: when considering not the central value of inflation, but the band (where the forecast may lie with a 5% error margin), it is obvious that the policymaker has a difficult time in choosing the right policy. For instance, if the inflation rate follows the upper margin of the band, more than 18 months might be needed to bring down the inflation rate.

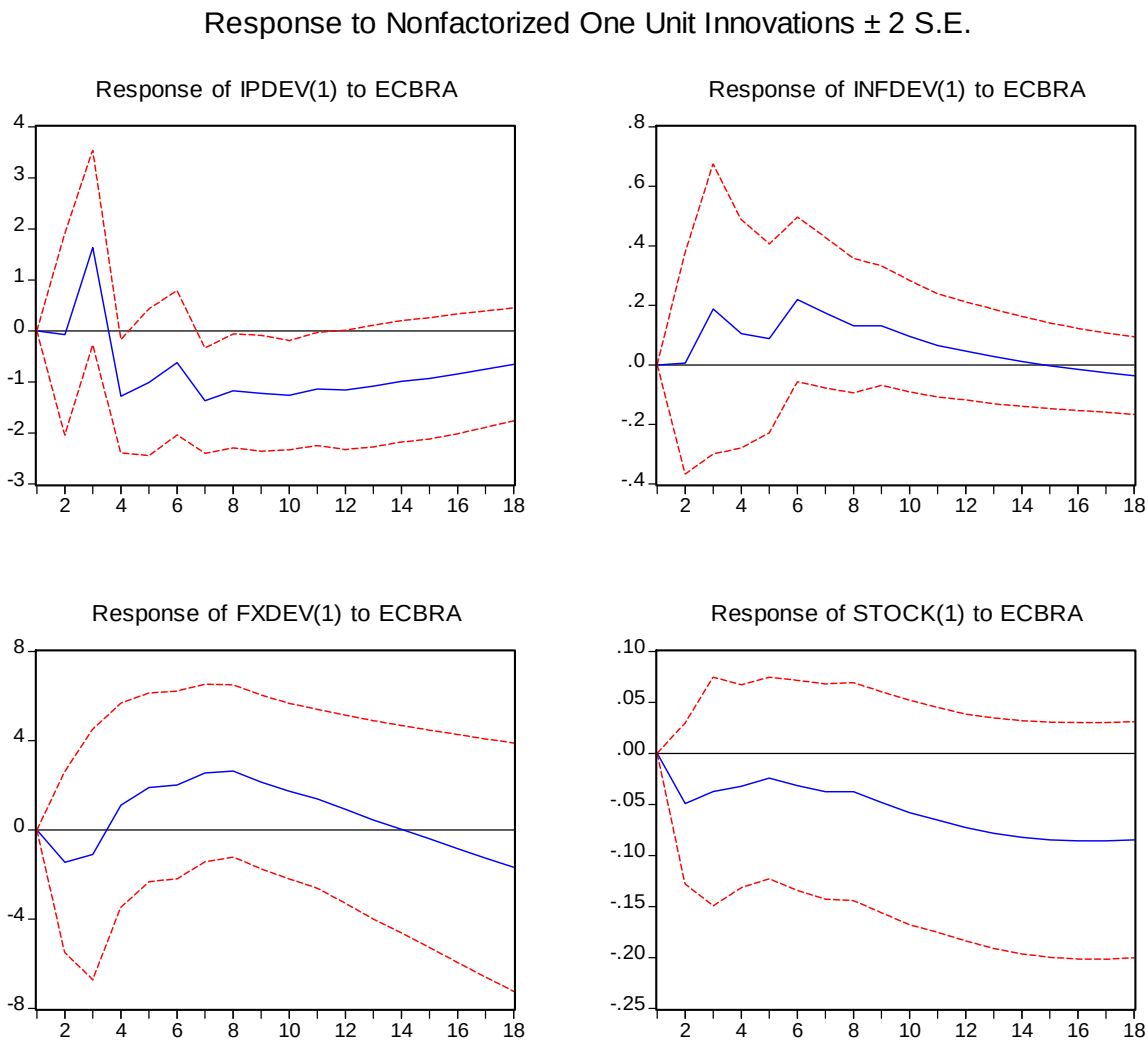

Figure 2. Impulse functions of the main variables in the euro area (response to an interest rate shock of one percentage point)

In order to carry a step further the comparison with the Fed, we also estimate a VAR model of the US, keeping the same variables but increasing the number of lags to seven so us to fulfill the Akaike criterion.

Inspection of the impulse functions (Figure 3) show that an increase in the US short term interest rate may lead to an immediate dollar appreciation (FXDEV is the same euro per dollar deviation from average as in the euro VAR), which might be explained by the existence of a more mature financial market in the US than in the euro area. Dollar appreciation has a first moderating impact on prices, which is then offset by a more sluggish response of output to the interest rate rise; more in detail, output growth is affected by the interest rate rise after 16 months. In the US the long run moderating impact on inflation can be recorded after a longer period than in the euro area, .i.e. after 24 months instead of 14.

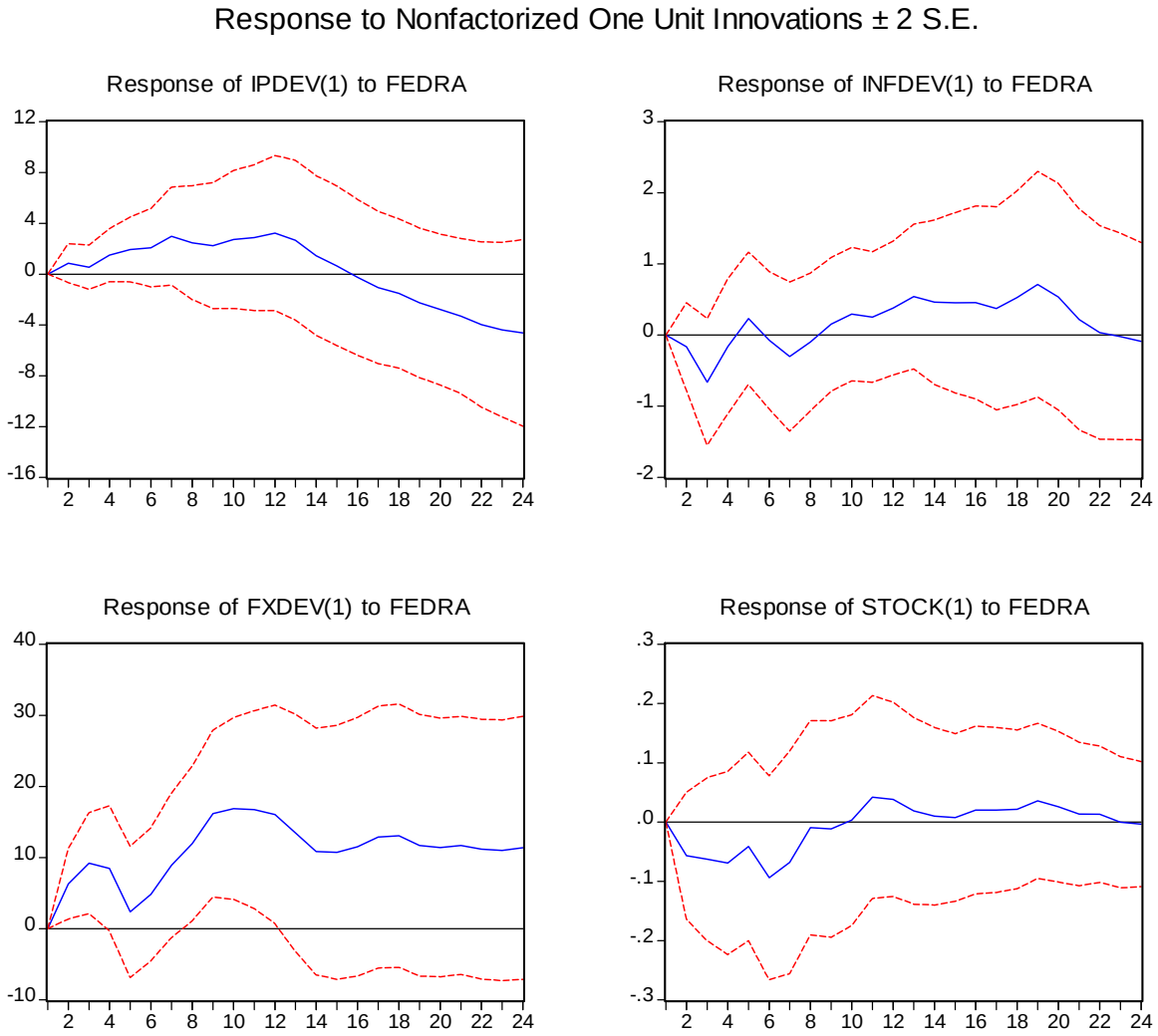

Figure 3. Impulse functions of the main variable in the US (response to an interest rate shock of one percentage point)

9. Conclusion

This paper presents an analysis of the ECB monetary policy both from a qualitative and a quantitative perspective, with some comparisons to the Fed. The qualitative approach builds on information deducted from various speeches of the President of the ECB, the Frenchman Jean-Claude Trichet, who took office in October 2003. The quantitative analysis builds on monthly data in the interval 1999.01-2005.08. It provides several estimates of the ECB and the Fed interest rate rule and develops a VAR model of both the euro area and the US economy so as to analyze the dynamic impact of an interest rate shock on the economy. Both analyses point to the difficult task of the ECB, especially when compared to the Federal Reserve Bank.

The qualitative analysis emphasizes the main goals of the ECB and presents the global "philosophy" of monetary policy making of the Bank, and compares it to the Fed's. It stresses the need and desire for the European Central Bank to establish and reinforce its credibility as an overriding means to control inflation so as to anchor inflationary expectations and sustain growth.

The quantitative analysis stands in line with the qualitative analysis, and points to the similarities between the ECB and the Fed policies in the past few years, by comparing two estimates of forward-looking interest rate rules over the period 2000-2005. The ECB appears to react strongly to inflation expectations. The VAR model of the euro area economy shows that after a one percentage point rise in the interest rate, inflation begins to decline with a lag of about 14 months and the decline may not be very substantial even after 18 months. Over the first months, moderate output growth may not temper inflation inasmuch as it would be associated to an euro depreciation, which in turn would have a positive impact on inflation. In the US, a positive interest rate shock's effect on inflation and real activity is even slower (24 months is the lag on inflation) and seems to be associated with dollar appreciation.

As any new institution, the ECB faces many difficulties in the conduct of its monetary policy, especially as far as it must deal with the specific constraint of credibility building. All these results, qualitative as well as quantitative, suggest that the ECB goals are not

significantly different from the Fed's. Differences between the two Banks in the conduct of monetary policy over the time period under consideration should be accounted for, apart from the credibility building policy of the ECB, by a different economic outlook, and differences in the economic structures of the two areas.

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Appendix 1. Euro area VAR Equations

Vector Autoregression Estimates
Sample (adjusted): 1999M04 2005M07
Included observations: 76 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	ECBRA	IPDEV(1)	INFDEV(1)	FXDEV(1)	STOCK(1)
ECBRA(-1)	0.598917	-0.071645	0.005648	-1.446214	-0.049165
	(0.11799)	(0.98654)	(0.18622)	(2.03016)	(0.03942)
	[5.07594]	[-0.07262]	[0.03033]	[-0.71236]	[-1.24714]
ECBRA(-2)	-0.016711	1.614309	0.177589	1.231533	0.049353
	(0.13794)	(1.15336)	(0.21771)	(2.37345)	(0.04609)
	[-0.12114]	[1.39965]	[0.81570]	[0.51888]	[1.07083]
ECBRA(-3)	0.149943	-2.581234	-0.157138	1.897087	-0.012561
	(0.10575)	(0.88419)	(0.16690)	(1.81953)	(0.03533)
	[1.41790]	[-2.91932]	[-0.94149]	[1.04262]	[-0.35550]
IPDEV	0.023813	0.213281	-0.011659	-0.121044	-0.000457
	(0.01310)	(0.10951)	(0.02067)	(0.22535)	(0.00438)
	[1.81821]	[1.94767]	[-0.56404]	[-0.53715]	[-0.10433]
IPDEV(-1)	0.014477	0.246403	-0.008022	-0.239857	0.004722
	(0.01335)	(0.11161)	(0.02107)	(0.22968)	(0.00446)
	[1.08450]	[2.20764]	[-0.38076]	[-1.04429]	[1.05864]
IPDEV(-2)	0.006702	0.310499	0.027850	0.113646	-0.000467
	(0.01340)	(0.11203)	(0.02115)	(0.23055)	(0.00448)
	[0.50016]	[2.77152]	[1.31693]	[0.49294]	[-0.10436]
INFDEV	0.136003	0.801410	0.872005	1.931005	0.007256
	(0.08105)	(0.67763)	(0.12791)	(1.39446)	(0.02708)
	[1.67812]	[1.18267]	[6.81722]	[1.38477]	[0.26798]
INFDEV(-1)	-0.025850	-0.227309	-0.226338	-0.823624	0.024141
	(0.10575)	(0.88422)	(0.16691)	(1.81960)	(0.03533)
	[-0.24444]	[-0.25707]	[-1.35605]	[-0.45264]	[0.68325]
INFDEV(-2)	0.029825	-1.292684	0.132523	-2.551212	-0.050674
	(0.07687)	(0.64268)	(0.12132)	(1.32255)	(0.02568)
	[0.38801]	[-2.01139]	[1.09239]	[-1.92902]	[-1.97318]
FXDEV	-0.004696	0.000650	0.030608	1.058677	0.002318
	(0.00735)	(0.06149)	(0.01161)	(0.12653)	(0.00246)
	[-0.63859]	[0.01057]	[2.63721]	[8.36709]	[0.94325]

FXDEV(-1)	0.017490	-0.053146	-0.018644	-0.459449	-0.002506
	(0.01025)	(0.08570)	(0.01618)	(0.17637)	(0.00342)
	[1.70634]	[-0.62012]	[-1.15246]	[-2.60509]	[-0.73160]
FXDEV(-2)	-0.003613	0.103907	-0.011607	0.236835	0.000253
	(0.00721)	(0.06031)	(0.01138)	(0.12411)	(0.00241)
	[-0.50089]	[1.72288]	[-1.01954]	[1.90826]	[0.10498]
STOCK	0.346083	-1.446231	-0.923122	-0.909220	1.097932
	(0.38441)	(3.21407)	(0.60670)	(6.61409)	(0.12843)
	[0.90031]	[-0.44997]	[-1.52154]	[-0.13747]	[8.54860]
STOCK(-1)	-1.022413	5.134851	0.371442	15.36743	-0.134251
	(0.57243)	(4.78615)	(0.90345)	(9.84921)	(0.19125)
	[-1.78610]	[1.07286]	[0.41114]	[1.56027]	[-0.70195]
STOCK(-2)	1.189697	-2.623854	0.297617	-7.732257	0.008389
	(0.40082)	(3.35128)	(0.63260)	(6.89645)	(0.13392)
	[2.96819]	[-0.78294]	[0.47047]	[-1.12119]	[0.06264]
C	0.254455	1.994347	0.203702	-11.50715	0.063082
	(0.18765)	(1.56898)	(0.29617)	(3.22874)	(0.06270)
	[1.35599]	[1.27111]	[0.68779]	[-3.56397]	[1.00616]
R-squared	0.985194	0.821999	0.792175	0.979569	0.973180
Adj. R-squared	0.981492	0.777499	0.740218	0.974462	0.966475
Sum sq. resids	1.012717	70.79770	2.522656	299.8119	0.113050
S.E. equation	0.129918	1.086260	0.205047	2.235367	0.043407
F-statistic	266.1534	18.47179	15.24694	191.7857	145.1423
Log likelihood	56.24836	-105.1449	21.56667	-159.9914	139.5658
Akaike AIC	-1.059167	3.188023	-0.146491	4.631351	-3.251733
Schwarz SC	-0.568487	3.678704	0.344189	5.122032	-2.761052
Mean dependent	2.976974	0.038618	0.070789	1.703601	0.974486
S.D. dependent	0.954967	2.302861	0.402299	13.98796	0.237069

Determinant resid covariance (dof adj.)	6.18E-06
Determinant resid covariance	1.90E-06
Log likelihood	-38.50460
Akaike information criterion	3.118542
Schwarz criterion	5.571946

VAR Lag Order Selection Criteria
Endogenous variables: ECBRA IPDEV(1) INFDEV(1) FXDEV(1) STOCK(1)
Exogenous variables: C
Date: 01/16/06 Time: 10:07
Sample: 1999M01 2005M08
Included observations: 72

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-462.0475	NA	0.296462	12.97354	13.13164	13.03648
1	-94.36438	674.0856	2.18e-05	3.454566	4.403177*	3.832211*
2	-63.64400	52.05398	1.88e-05	3.295667	5.034787	3.988015
3	-29.15037	53.65676*	1.48e-05*	3.031955*	5.561584	4.039008
4	-11.73913	24.66593	1.92e-05	3.242754	6.562892	4.564510
5	13.69588	32.50028	2.06e-05	3.230670	7.341317	4.867131
6	39.27421	29.13087	2.31e-05	3.214605	8.115762	5.165770
7	60.12113	20.84693	3.15e-05	3.329969	9.021634	5.595837

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Appendix 2. US VAR Equations

Vector Autoregression Estimates
Date: 01/23/06 Time: 19:11
Sample (adjusted): 1999M08 2005M07
Included observations: 72 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	FEDRA	IPDEV(1)	INFDEV(1)	FXDEV(1)	STOCK(1)
FEDRA(-1)	1.018141	0.851674	-0.163215	6.295977	-0.056853
	(0.21113)	(0.76430)	(0.30835)	(2.46730)	(0.05347)
	[4.82229]	[1.11432]	[-0.52931]	[2.55177]	[-1.06335]
FEDRA(-2)	0.152410	-0.643026	-0.273633	-2.985266	-0.030237
	(0.25130)	(0.90971)	(0.36701)	(2.93669)	(0.06364)
	[0.60649]	[-0.70685]	[-0.74557]	[-1.01654]	[-0.47515]
FEDRA(-3)	0.138748	0.744360	0.523024	-2.599059	0.016140
	(0.23825)	(0.86246)	(0.34795)	(2.78418)	(0.06033)
	[0.58237]	[0.86307]	[1.50314]	[-0.93351]	[0.26751]
FEDRA(-4)	-0.459236	-0.491558	-0.207069	-4.609074	0.058461
	(0.25200)	(0.91224)	(0.36804)	(2.94487)	(0.06381)
	[-1.82237]	[-0.53885]	[-0.56263]	[-1.56512]	[0.91611]
FEDRA(-5)	0.178803	-0.159547	0.036838	8.168912	-0.064257
	(0.22179)	(0.80288)	(0.32392)	(2.59184)	(0.05616)
	[0.80618]	[-0.19872]	[0.11373]	[3.15178]	[-1.14408]
FEDRA(-6)	0.028281	0.239525	0.078011	-0.177021	0.019056
	(0.22211)	(0.80403)	(0.32438)	(2.59555)	(0.05624)
	[0.12733]	[0.29791]	[0.24049]	[-0.06820]	[0.33881]
FEDRA(-7)	-0.116103	-0.275810	0.010783	-1.438960	0.060530
	(0.18026)	(0.65255)	(0.26327)	(2.10657)	(0.04565)
	[-0.64407]	[-0.42266]	[0.04096]	[-0.68308]	[1.32600]
IPDEV	0.007551	0.360257	-0.050680	-0.358732	0.024164
	(0.05176)	(0.18738)	(0.07560)	(0.60488)	(0.01311)
	[0.14589]	[1.92265]	[-0.67042]	[-0.59306]	[1.84351]
IPDEV(-1)	-0.023650	0.369788	0.160997	-0.801020	0.000790
	(0.05100)	(0.18462)	(0.07448)	(0.59600)	(0.01292)
	[-0.46372]	[2.00294]	[2.16148]	[-1.34400]	[0.06115]
IPDEV(-2)	0.017318	0.100758	-0.036277	0.083577	0.009403
	(0.05273)	(0.19088)	(0.07701)	(0.61620)	(0.01335)
	[0.32843]	[0.52786]	[-0.47108]	[0.13563]	[0.70422]
IPDEV(-3)	-0.022836	-0.279441	-0.057627	1.354451	0.007545

	(0.05123)	(0.18547)	(0.07482)	(0.59872)	(0.01297)
	[-0.44573]	[-1.50669]	[-0.77016]	[2.26225]	[0.58151]
IPDEV(-4)	-0.008334	0.278347	0.017518	0.300540	-0.016439
	(0.05062)	(0.18324)	(0.07393)	(0.59152)	(0.01282)
	[-0.16464]	[1.51906]	[0.23697]	[0.50808]	[-1.28251]
IPDEV(-5)	0.061995	0.301178	0.136143	-0.640813	-0.003403
	(0.04750)	(0.17195)	(0.06937)	(0.55508)	(0.01203)
	[1.30515]	[1.75155]	[1.96251]	[-1.15444]	[-0.28292]
IPDEV(-6)	-0.030763	-0.505067	-0.037115	-1.222158	0.017674
	(0.04942)	(0.17892)	(0.07218)	(0.57758)	(0.01252)
	[-0.62242]	[-2.82289]	[-0.51418]	[-2.11599]	[1.41215]
INFDEV	-0.056715	0.137529	0.892398	1.628033	-0.082302
	(0.14463)	(0.52355)	(0.21122)	(1.69011)	(0.03662)
	[-0.39215]	[0.26269]	[4.22494]	[0.96327]	[-2.24719]
INFDEV(-1)	0.072005	-0.115007	-0.829400	1.666633	0.008779
	(0.14872)	(0.53839)	(0.21721)	(1.73801)	(0.03766)
	[0.48415]	[-0.21361]	[-3.81847]	[0.95893]	[0.23309]
INFDEV(-2)	0.046944	-0.641922	0.520051	-2.025251	-0.033093
	(0.17957)	(0.65004)	(0.26225)	(2.09844)	(0.04547)
	[0.26143]	[-0.98751]	[1.98301]	[-0.96512]	[-0.72774]
INFDEV(-3)	-0.023893	0.004388	-0.145344	-2.616024	0.022495
	(0.21661)	(0.78414)	(0.31636)	(2.53136)	(0.05485)
	[-0.11030]	[0.00560]	[-0.45943]	[-1.03345]	[0.41008]
INFDEV(-4)	-0.110245	-0.748283	0.010021	2.471322	0.023016
	(0.18551)	(0.67155)	(0.27093)	(2.16787)	(0.04698)
	[-0.59428]	[-1.11427]	[0.03699]	[1.13998]	[0.48995]
INFDEV(-5)	0.069398	0.193513	0.134637	-1.964316	0.017600
	(0.16238)	(0.58781)	(0.23715)	(1.89755)	(0.04112)
	[0.42739]	[0.32921]	[0.56774]	[-1.03519]	[0.42802]
INFDEV(-6)	-0.082782	0.201613	-0.010188	1.714729	0.054466
	(0.12672)	(0.45874)	(0.18508)	(1.48090)	(0.03209)
	[-0.65325]	[0.43949]	[-0.05505]	[1.15790]	[1.69726]
FXDEV	0.015566	0.040896	-0.021777	1.026586	0.004152
	(0.01344)	(0.04864)	(0.01962)	(0.15702)	(0.00340)
	[1.15848]	[0.84080]	[-1.10975]	[6.53804]	[1.22033]
FXDEV(-1)	0.001215	-0.061865	0.045516	-0.187334	-0.010382
	(0.02205)	(0.07984)	(0.03221)	(0.25773)	(0.00558)
	[0.05511]	[-0.77488]	[1.41311]	[-0.72686]	[-1.85896]

FXDEV(-2)	0.011167	0.090904	-0.010151	-0.379519	0.007932
	(0.02267)	(0.08205)	(0.03310)	(0.26487)	(0.00574)
	[0.49268]	[1.10791]	[-0.30665]	[-1.43284]	[1.38188]
FXDEV(-3)	-0.031015	-0.069273	-0.014175	-0.005014	-9.23E-05
	(0.02254)	(0.08158)	(0.03291)	(0.26337)	(0.00571)
	[-1.37619]	[-0.84911]	[-0.43066]	[-0.01904]	[-0.01617]
FXDEV(-4)	0.018941	-0.006375	-0.005220	0.400011	-0.004886
	(0.02068)	(0.07487)	(0.03020)	(0.24169)	(0.00524)
	[0.91584]	[-0.08515]	[-0.17281]	[1.65508]	[-0.93298]
FXDEV(-5)	-0.007663	-0.043895	0.010130	-0.091006	0.001474
	(0.01850)	(0.06697)	(0.02702)	(0.21620)	(0.00468)
	[-0.41418]	[-0.65542]	[0.37490]	[-0.42094]	[0.31453]
FXDEV(-6)	-0.007081	-0.006448	-0.006217	-0.074154	0.001449
	(0.01403)	(0.05077)	(0.02048)	(0.16390)	(0.00355)
	[-0.50487]	[-0.12700]	[-0.30352]	[-0.45243]	[0.40790]
STOCK	0.329975	4.090274	-1.857421	1.668721	0.612590
	(0.62382)	(2.25825)	(0.91107)	(7.29003)	(0.15797)
	[0.52896]	[1.81126]	[-2.03872]	[0.22890]	[3.87781]
STOCK(-1)	-1.190252	-2.404243	0.955425	-1.127185	-0.311605
	(0.81066)	(2.93460)	(1.18394)	(9.47342)	(0.20529)
	[-1.46825]	[-0.81927]	[0.80699]	[-0.11898]	[-1.51790]
STOCK(-2)	2.747168	4.322634	-0.279423	9.219858	-0.031294
	(0.83975)	(3.03991)	(1.22643)	(9.81340)	(0.21265)
	[3.27140]	[1.42196]	[-0.22783]	[0.93952]	[-0.14716]
STOCK(-3)	-1.321162	-3.066732	0.972510	-15.07277	0.048710
	(0.93051)	(3.36846)	(1.35898)	(10.8740)	(0.23564)
	[-1.41982]	[-0.91043]	[0.71562]	[-1.38613]	[0.20672]
STOCK(-4)	0.411731	-2.458680	0.740125	-7.919724	0.048983
	(0.92470)	(3.34743)	(1.35050)	(10.8061)	(0.23417)
	[0.44526]	[-0.73450]	[0.54804]	[-0.73289]	[0.20918]
STOCK(-5)	-1.386678	0.190802	-2.238411	-13.76515	0.240849
	(0.83585)	(3.02579)	(1.22073)	(9.76780)	(0.21167)
	[-1.65900]	[0.06306]	[-1.83366]	[-1.40924]	[1.13787]
STOCK(-6)	0.830522	1.195592	1.500284	23.03170	-0.213769
	(0.70143)	(2.53918)	(1.02441)	(8.19693)	(0.17763)
	[1.18404]	[0.47086]	[1.46453]	[2.80980]	[-1.20348]
C	-0.301530	-3.080774	0.076264	-3.193286	0.648348
	(0.68165)	(2.46758)	(0.99553)	(7.96581)	(0.17262)
	[-0.44235]	[-1.24850]	[0.07661]	[-0.40087]	[3.75599]

R-squared	0.995939	0.980592	0.937819	0.989383	0.882611
Adj. R-squared	0.991991	0.961723	0.877366	0.979062	0.768484
Sum sq. resids	1.139565	14.93340	2.430649	155.6234	0.073077
S.E. equation	0.177917	0.644063	0.259842	2.079152	0.045055
F-statistic	252.2604	51.96805	15.51310	95.85460	7.733534
Log likelihood	47.09312	-45.53320	19.82272	-129.9114	145.9809
Akaike AIC	-0.308142	2.264811	0.449369	4.608650	-3.055026
Schwarz SC	0.830191	3.403144	1.587702	5.746983	-1.916692
Mean dependent	3.006944	-0.290547	-0.386500	1.783626	1.067756
S.D. dependent	1.988068	3.291979	0.742001	14.36863	0.093637

Determinant resid covariance (dof adj.)	3.81E-06
Determinant resid covariance	1.19E-07
Log likelihood	63.17496
Akaike information criterion	3.245140
Schwarz criterion	8.936805

VAR Lag Order Selection Criteria
Endogenous variables: FEDRA IPDEV(1) INFDEV(1) FXDEV(1) STOCK(1)
Exogenous variables: C
Date: 01/23/06 Time: 19:23
Sample: 1999M01 2005M08
Included observations: 72

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-546.9891	NA	3.138216	15.33303	15.49113	15.39597
1	-104.1139	811.9378	2.86e-05	3.725387	4.673998*	4.103032*
2	-79.56275	41.60063	2.93e-05	3.737854	5.476974	4.430203
3	-42.63256	57.44696*	2.15e-05*	3.406460	5.936089	4.413513
4	-23.00223	27.80963	2.63e-05	3.555617	6.875756	4.877374
5	-2.445648	26.26674	3.23e-05	3.679046	7.789693	5.315507
6	30.09794	37.06353	2.98e-05	3.469502	8.370658	5.420667
7	63.17496	33.07702	2.89e-05	3.245140*	8.936805	5.511009

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

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