The European Journal of Comparative Economics
Vol. 2, n. 1, pp. 111-136
ISSN 1824-2979

European Economic Policies at Work : the costs of Price Stability and Budget Consolidation

Carlo Altavilla[1] – Ugo Marani[2]
Università di Napoli Parthenope – Università di Napoli Federico II

Abstract

The paper investigates whether the policy framework adopted by the EMU participating countries might create recessive tendencies. First, we check the existence of a deflationary bias by separately analysing monetary and fiscal policy. The analysis of monetary policy focuses on a backward- and a forward-looking monetary rule. The reaction functions are estimated to capture the criteria that a centralized monetary authority should use in setting short-term interest rate. Second, a comparative analysis is made of the ability of different central banks to stabilize output and inflation. Precisely, we compare the strategy followed by the European Central Bank, the Deutsche Bundesbank and the US Federal Reserve. Then, a measure of fiscal bias is retrieved by estimating the impact that a change in the primary surplus to GDP ratio has on the real economy. Finally, we search for a quantitative assessment of the recessive propensity of the European economic policies by estimating an overall policy bias. The results suggest the EU institutional set-up might create and/or amplify the recessive tendencies. The policy constraints the EMU members face were dreamt when the Community was struggling with an inflationary legacy. The danger nowadays is not inflation but rather its opposite, deflation. As a consequence, the EU institutions need to be at least partially reformed.

JEL Classification: C52, E52

Keywords: Monetary and Fiscal Strategy, ECB, EMU

1. Introduction

This paper deals with the characteristics of the economic policies pursued in European Monetary Union (henceforth EMU) and with their theoretical fundamentals. The main interpretative hypothesis underlying the study is that a deflationary bias is embodied in the way the policy authorities act within the European framework.

This recessive propensity depends on the overall criteria concerning the institutional commitments on the conduct of both monetary and fiscal policies. More specifically, the commitment of price stability for the European Central Bank (ECB) together with the commitment of financial stability for the member state governments aims at achieving the minimum inflation rate without any matter to employment and production levels. We could define the European deflationary bias as a policy that, in conditions of neutrality, transmits recessive impulses to the economy.

The approach of overall European economic policies is founded on specific theoretical hypothesis that can be easily retraced in the ECB and European Commission documents. A clear distinction between the policy makers and the politicians, that are supposed to suffer of "inflationary bias"; the central role of monetary stability; the neutrality of monetary policy and hence the ineffectiveness of aggregate demand based policies; the destabilizing effects of high public deficit and debt according to the validity of "equivalence theorem".

[1] E-mail: Altavilla@uniparthenope.it
[2] E-mail: Marani@unina.it

We form the hypothesis that the deflationary bias is a legacy of the Maastricht Treaty, i.e. of the strong commitment to fiscal and monetary policies of candidates' countries. Hence, using a database that covers a period preceding the launch of euro, we try to check the potential deflationary bias of current policies.

The remainder of the paper proceeds as follows. Section 2 introduces the structural model used in the empirical analysis and presents the econometric methodology applied in order to evaluate the existence of a monetary policy deflationary bias. In particular, a backward- and a forward-looking monetary rule are estimated to capture the criteria used by European Central Bank to fix short term interest rate. An efficiency frontier analysis and a comparison of the results with the behaviour of Deutsche Bundesbank and Federal Reserve are also provided. In Section 3, a measure of fiscal bias is obtained by estimating the impact of primary surplus on European output gap. Section 4 concerns a quantitative evaluation of the recessive propensity of both monetary and fiscal policies. In Section 5 concluding remarks end the paper.

2. An Evaluation of Monetary Policy Strategy

In this section we present different frameworks developed for monetary policy analysis thought to be used as a measure of monetary stance. At our aims we start from a definition of rule-based monetary policy. As no central bank will be bound by implementing the prescription of any simple rule (or any optimal control algorithm), the distinction between rule-based and discretionary monetary policy is crucial. As stressed in McCallum (2000), while a discretionary monetary policy take into account the current macroeconomic condition, ignoring the past development in the economic system, a rule-based behaviour is based on a "timeless perspective", i.e. the rule is constructed as if the current conditions were not known3.

The reason why a central bank should adopt a monetary rule, instead of having a discretionary behaviour, has a theoretical basis in the time-consistency literature. In this literature, whose seminal contributions are due to Kydland and Prescott (1977) and Barro-Gordon (1983), is shown that if a central bank does not commit itself to a rule the policymakers will be tempted to choose a suboptimal inflation policy4. In the empirical study we perform the following counterfactual exercise: we ask how the monetary policy would have been conducted if, during the last decades, there had been a European Central Bank created through a weighted reaction function of the EMU participating countries to take into account the different economic structures

[3]According to this definition, while following a discretionary policy the central bank reoptimizes period-by-period his decision process, in a rule-based policy the monetary authority implements period-by-period a contingency formula chosen to be applied for an infinite number of periods. Nevertheless, in the rule-based framework is also contemplated the possibility of revising the rule, once the central banks get new information on the work of the economy.

[4]The contribution of Barro and Gordon is of particular interest for the issues analyzed in the paper because it permitted to separate the "rules vs. discretion" dichotomy from the debate on "activist vs. non-activist" central bank behaviour. This separation has resulted in a possibility for the monetary policymaking to concentrate on the issue of policy rules. Moreover, there are other advantages the central bank can obtain by limiting the range of the possible policies, i.e. adopting a rule. A first is an increase in the monetary policy credibility. A second is the decrease in the market participants' uncertainty coming from the better forecast of the future policy actions.

peculiarities5. In this respect, different monetary rules are estimated using alternative econometrics techniques. The different estimated rules are capable of modelling how central banks of the EMU Countries have made policy choices affecting interest rates6. In particular, the study has focused on two models relating the interest rate, that the ECB is assumed to control, to a set of variables7 thought to affect monetary authorities' behaviour. A first framework, used to analyse the problem the ECB faces in setting a single monetary policy rule, refers to the optimal control algorithm. The econometric methodology applied is based on a small structural model similar to the one developed by Rudebush and Svensson (1998) that is very close to the model specified in the previous section. In a second step, we take into account more explicitly the forward-looking behaviour of the central bank by estimating a single equation reaction function like in Clarida et al. (1998). Those approaches provide insight for how the new European monetary institution should conduct and characterize its policy strategy. In other word, it can suggest how the ECB should move interest rate once a change in real output, inflation or exchange rate occurs. Moreover, we can also characterize the main features of the monetary policy conduct the central banks of the European countries have had over the past decade. In particular, following our hypothesis we are interesting in assessing whether the monetary stance of the European Countries have been too tight, implying a deflationary bias, or the actual interest rate have met the "optimal" monetary behaviour suggested by different monetary rules.

2.1 A Structural Model of European Economy

In the literature several types of models have been used for evaluating monetary policy rules, including optimizing model with representative agents, closed and open economy models, rational expectations models8. The model we will use to analyse the central bank behaviour is a backward-looking closed-economy model. The relations between the variable are thought to be representative of the major effects that monetary policy has on inflation and output. The features of the model are very important because the conclusions obtained depend, of course, from the belief that the economic structure implied by the proposed model is not grossly incorrect.

The model consists of an aggregate supply equation of the form:

$$\pi_{t+1} = \sum_{i=1}^{4} \alpha_i \pi_{t+1-i} + \alpha_5 y_t + u^{\pi}{}_{t+1} \qquad [1]$$

[5]Using this counterfactual technique two caveats have to be stressed: on the one hand, such a methodology has been widely used so far by the major researchers of the ECB's conduct; on the other hand, as the analysis covers the whole ERM period, i.e. before the birth of the ECB, the estimates are less subject to the Lucas' critique.

[6]In doing it the underlined assumption is that there is a deep continuity and legacy between the "weighted" ECB and the "actual" ECB.

[7] See Appendix 1 for the aggregation method used to obtain euro-area time series

[8] As notice in Taylor (1998), despite the differences in the models used for studying the monetary policy, they share some important peculiarity.

This autoregressive Phillips curve relates inflation rate to a lagged output gap (y), measured as a percent gap between actual real GDP and potential GDP, and to four lags of HICP inflation. The underlined structure of aggregate supply is consistent with an adaptive representation of inflation expectations. The expectations are treated implicitly by the inclusion of lagged values of the variables. There is little theoretical consensus on how inflation affects real economy. Much of the empirical literature looks for a negative influence of inflation on output gap. Yet many economic theories predict neutrality or even a positive effect of average inflation on economic performance.

The particular specification of the inflation process is also important. The absence of forward-looking variables in the estimated model is in line with the analysis of Fuhrer (1997) on the importance of the future price expectations in explaining price and inflation behaviour. He finds that the performance of a model builds for a pure forecasting purpose with a forward-looking specification of the inflation is not better than a backward-looking model.

$$y_{t+1} = \sum_{i=0}^{2} \beta_i y_{t+1-i} + \beta_3 \left(\overline{i}_t - \overline{\pi}_t \right) + u^y{}_{t+1} \qquad [2]$$

According to the above equation the output gap is related to its own lags and to the differences between a short-term interest rate and the inflation rate. In the above equation $\overline{i}$ is the quarterly average short-term interest rate and $\overline{\pi}_t$ is the four-quarter inflation, i.e. $\frac{1}{4}\sum_{j=1}^{4} \pi_{t-j}$. With this specification of the model interest rate is considered as an exogenous variable under the perfect control of monetary authorities. The timing of the model can be summarized as follow: an increase in monetary policy instrument i in period t affects output with one period lag and takes another period, i.e. at time t+2, for output to affect inflation.

The timing and the size trough which inflation affects real economy is a crucial topic. It is important, because if inflation has real effects, monetary authorities can influence economic performance through monetary policy.

The model has been estimated by applying the Seemingly Unrelated Regression (SUR) technique9 and using quarterly data for the period 1980-1998. The variables involved in the study comprising output gap, HICP inflation and nominal interest rate. The evidence emerging from standard univariate unit root tests shows that all variables are stationary, i.e. they are I(0). Moreover, all variables were de-meaned prior to estimation.

[9] In this case we use the SUR technique to take into account the relationships among the estimated variables in the variance-covariance matrix.

The estimated equations are (coefficient standard errors are given in parentheses):

	π_t	π_{t-1}	π_{t-2}	π_{t-3}	y_t
π_{t+1}	1.2	-0.3	0.25	-0.15	0.13
	[0.18]	[0.20]	[0.12]	[0.14]	[0.11]

R^2=0.92, SEE=0.28, DW=1.81

Heteroscedasticity (ARCH 1 Test, $\chi2$(1): 2.31 [0.12]

Normality (Hansen-Test): 2.197 [0.33]

Stability (Joint Statistic): 1.472 (critical value: 1.68)

Autocorrelation (Ljung-Box Q-Statistic): 20.386

	y_t	y_{t-1}	$i_t - \pi_t$
y_{t+1}	1.14	-0.3	-0.09
	[0.14]	[0.16]	[0.04]

R^2=0.8, SEE=0.31, DW=2.1

Heteroscedasticity (ARCH 1 Test, $\chi2$(1): 0.71 [0.3]

Normality (Hansen- Test): 2.641 [0.31]

Stability (Joint Statistic): 0.71 (critical value: 1.24)

Autocorrelation (Ljung-Box Q-Statistic): 16.49 [0.62]

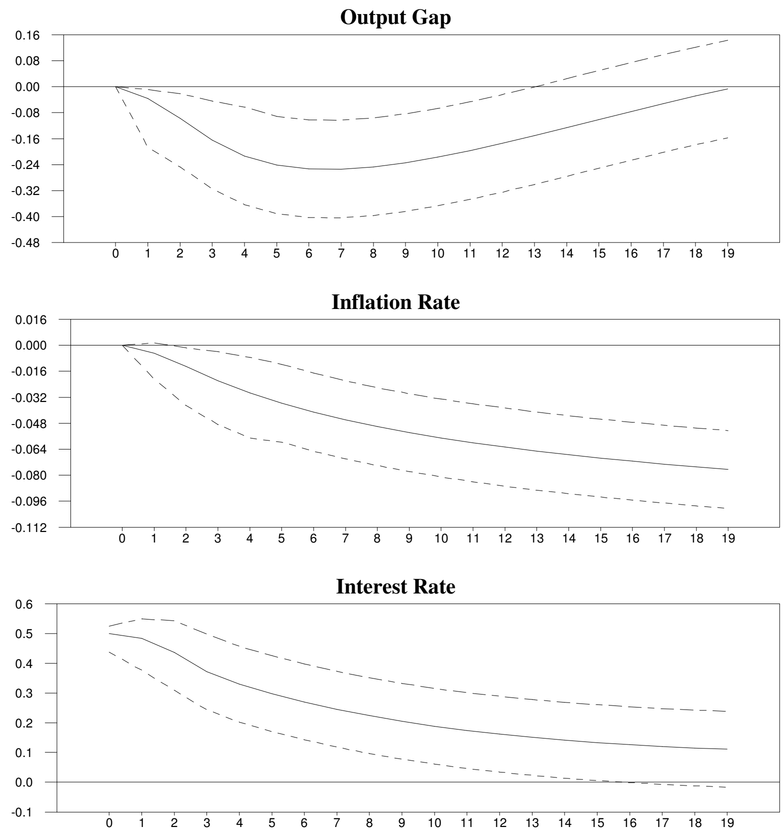
At a first glance, the model seems to perform rather well. Almost all coefficients are significant at the 5% level. The hypothesis that the sum of the lag coefficients of inflation is equal to unity has a p-value of 0.74, so we imposed this restriction in estimation. This means that there is a natural unemployment rate (NAIRU) when inflation is stable. In fact, a sum of the response coefficients on lagged inflation equal to unity implies a vertical log-run Phillips curve.

A battery of diagnostic tests has been employed in order to test for autocorrelation, heteroscedasticity, parameter stability and normality. For both inflation and output equation the Ljung-Box (Q) statistics are significant at all lags indicating that the residuals are serially uncorrelated. In order to test for heteroscedasticity we implement the standard test for time-varying variance developed by Engle (1982). Under the null hypothesis of constant variance the tests reject the presence of heteroscedasticity in the two equations. The stability of the parameters in model was formally tested with a standard Hansen's (1991) stability test. This test not rejects the null of no-structural change in the output and inflation process over the sample period.

The structure of the model is very important because the conclusions reached in this section depend, of course, on the belief that the economic structure implied by the proposed model is not grossly incorrect. For this reason, we tried to asses the validity of the model in two ways. First, we estimated the model using different lag structures for output and inflation. The results we get are not significantly different from the one obtained with our model. Second, we perform an impulse response analysis in order to measure the time profile of the incremental effect of variables' innovation on the future state of the economy. The responses of inflation and output gap to an unanticipated shock in interest rate are shown in Figure 1.

Consistently with the a priori beliefs both inflation and output gap fall after a contractionary monetary policy shock. The shape of the responses is also important: they show a certain degree of rigidity in inflation response and a hump-shaped response function for output gap. This means the model is not grossly incorrect. We, then, proceed to the estimation of the optimal feedback rule.

Figure 1: Response to a Contractionary Monetary Policy Shock



2.1.1 The Computation of the Optimal Feedback Rule

The class of rules considered here is the targeting rule. In the targeting rule framework a central bank is assigned to minimize a loss function that has a positive relation with the deviation between a target variable and the target level for this variable. More explicitly, the central bank is supposed to minimise an intertemporal loss function of the form:

$$E_t\left\{\sum_{\tau=0}^{\infty}\delta^{\tau}\left[\lambda\overline{\pi}_{t+\tau}{}^{2}+\vartheta y_{t+\tau}^{2}+\gamma\left(i_{t+\tau}-i_{t+\tau-1}\right)^{2}\right]\right\} \qquad [3]$$

Where E_t refers to expectations conditional upon the available information set at time t, while δ is a given discount factor, with $0<\delta<1$.

Moreover, λ, γ and ϑ are non-negative weights the central bank attaches to inflation stabilization, output stabilization and interest rate smoothing, respectively. If λ

is set to one and γ and ϑ are set to zero, we are in a situation of strict inflation targeting. The specific features of the loss function that has to be considered raise some problems10.

Following the terminology introduced in Svensson (1997), equation [3] describes a flexible inflation target where the goal variables describing the central bank's preferences are $\overline{\pi}_{t+\tau}$, i.e. the deviation of actual inflation from a constant given inflation target, $y_{t+\tau}$, i.e. the output gap and $i_t - i_{t-1}$, an interest rate smoothing term. Moreover, some words have to be spent on the variables that enter in the loss function. In real monetary policy making the inflation rate is usually preferred to output gap as a formal target for monetary policy. The reasons are related to the specific features the inflation rate has in comparison with the output gap. From a theoretical point of view, the long-run neutrality of monetary policy on output capacity suggest the central banks should concentrate on the variables, like inflation rate, they are able to influence on a long-term basis. From a practical point of view, the difficulty in measuring the output gap and the familiarity with the concept of inflation among the people support the superiority of inflation for central banks communication and econometrics estimation purposes respectively. Nevertheless, even if central bank official target is expressed in term of inflation, it is possible to suppose the monetary authorities still care about output stabilization. Finally, the inclusion of interest rate smoothing objective is proposed to account for two phenomena. The first is the aversion that the central banks have to change frequently the direction of their strategy. The second reason is related to the idea that central banks care also about financial stability: interest rate instability could lead to a destabilization of the financial system.

As shown in Rudebush and Svensson (1998), for δ =1, we can rewrite the optimisation problem interpreting the intertemporal loss function as the unconditional mean of the period loss function; it means that the intertemporal loss function can be written as the weighted sum of the unconditional variances of the goal variables:

$$E[L_t] = Var[\overline{\pi}_t] + \lambda Var[y_t] + \nu Var[i_t - i_{t-1}] \quad [4]$$

where π and y represent respectively the deviation from a constant inflation target and the output gap.

The State space representation of the estimated model is:

$$X_{t+1} = AX_t + Bi_t + v_{t+1} \quad [5]$$

[10] Several authors have stressed the perverse attitude to risk of the quadratic loss function: utilizing such function we are implicitly assuming the central bank treats symmetrically both positive and negative deviation from the target. Even so, as shown in Chadha and Shellekens (1999), conducing the analysis with different attitude to risk through the introduction of an exponential (CARA) or isoelastic (CRRA) loss function does not produce, in a contest of additive uncertainty, a richer description of the policymakers' behaviour. In fact also in those cases certainty equivalence applies, provided the alternative loss function is symmetric. For those reasons in the rest of the paper is used a quadratic loss function.

The class of linear feedback rules considered here takes the following generic form:

$$i_t = fX_t \qquad [6]$$

where f denotes a 1×9 vector[11]. The reaction function following from flexible inflation targeting, with λ=0.4, ϑ=0.4 and γ=0.2 is:

$$i_t = 0.48\pi_t + 0.37\pi_{t-1} + 0.21\pi_{t-2} + 0.11\pi_{t-3} + 0.95y_t - 0.02y_{t-1} + 0.66i_{t-1} - 0.04i_{t-2} - 0.01i_{t-3}$$

The estimated response coefficients are in line with the one obtained in previous studies. In particular, the output gap coefficient, i.e. $\frac{\partial i_t}{\partial y_t} = 0.95$, implies a large reaction of policy rate to current output gap. The interest rate smoothing term also has a significant response coefficient, $\frac{\partial i_t}{\partial i_{t-1}} = 0.66$.

The capability of the recovered feedback rule in reproducing the actual interest rate is shown in Figure 2.

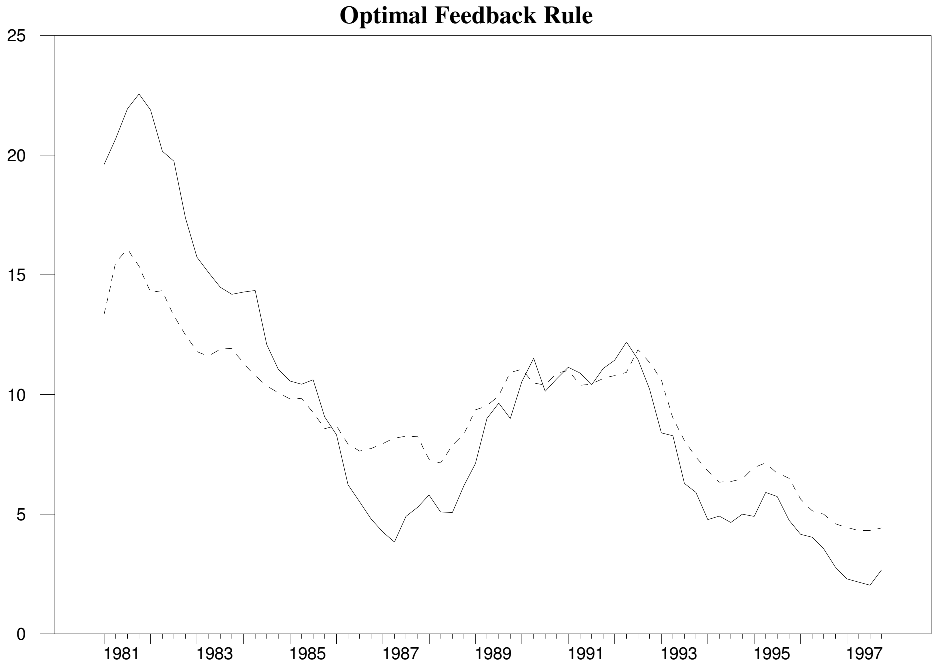
From this analysis emerges that the optimal rule performs quite well in replicating the actual interest rate movements. The figure also suggest that for most of the 1990s the actual interest rate resulted from the monetary conduct of the European countries has been higher than the interest rate suggested from the optimal feedback rule. This evidence is consistent with a monetary policy that overweighs the inflationary pressure, implying a deflationary bias[12].

---

[11] See Appendix 3 for the computation of the feedback rule

[12] The same conclusion is reached by von Hagen et al. (2001), when they affirm that a "Maastricht Effect" prevailed in Europe during the '90s due to the lack of interest rate decreases consistent with a growing budgetary consolidation in EU countries. A striking difference of our results, compared with those of the mentioned study, is the presence of output reduction resulting from "Maastricht Effect". A further attempt to estimate the sacrifice ratio between the inflation lowering and the steady state unemployment for France, Germany, Spain and United Kingdom is contained in Wyplosz (2000).

Figure 2: Estimated Rules (solid line) vs. Actual Interest Rate (dashed line)



2.1.2 The Performance of Different Rules

The monetary strategy announced by the ECB Governing Council in October 1998 clarified that the primary objective of monetary policy in the euro area is the price stability. We can then compare a rule that aims at targeting only inflation rate, representing the ECB strategy, with other rules that account for other target variables. In the comparative analysis the weights on inflation stabilization around the inflation target and output-gap stabilization are normalized to sum to one.

Given the weight on interest-rate smoothing fixed to 0.2, we define flexible inflation targeting (FIT) as λ=0.4, ϑ =0.4; inflation targeting (IT) as λ=0.8, ϑ=0.2; output-gap targeting (OT) as λ=0.2, ϑ=0.8. We also examine the performance of three rules that not account for interest-rate smoothing, i.e. γ=0. In particular we consider strict inflation targeting (SIT) as λ=1, ϑ=0; strict output-gap targeting (SOT) as λ=0, ϑ =1; and a flexible inflation target without interest smoothing (NIS) as λ=0.5, ϑ=0.5.

We compute the efficiency frontier for output-gap and inflation standard deviation. This frontier, measuring the best trade-off between inflation and output-gap volatility, is generated by setting γ=0.2, letting λ=0.8-ϑ and letting ϑ vary from 0 to 0.8.

The figure shows that the central bank can achieve a lower level of inflation stability by accepting a higher volatility of output gap. There is, in other words, a trade-off between output gap volatility and the institutional target of the ECB. The figure also indicates that when the interest rate smoothing term is not taken into account, as for rules SIT and SOT, the resulting output and inflation volatility is higher compared to the efficiency frontier. Thus, when there is some positive weight on interest rate smoothing, the resulting combination of inflation and output-gap variability will be efficient.

Figure 3: Efficiency Frontier

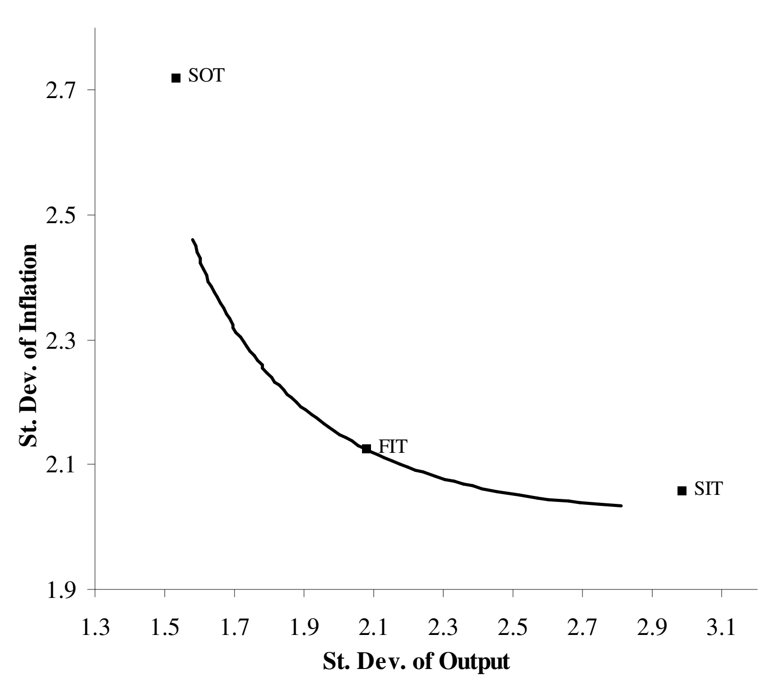


Table 1 provides the results for the six different sets of preferences over goals.

Table 1: Results on Volatility and Loss with Different Rules

Rules	λ	θ	γ	$Std[\pi_t]$	$Std[y_t]$	$Std[i_t - i_{t-1}]$	*Loss*	*Rank*
ST	1	0	0	1.37	5.20	9.20	28.40	5
IT	0.8	0.2	0.2	1.57	2.10	1.03	2.96	2
FIT	0.4	0.4	0.2	1.89	1.50	1.56	2.81	1
NIS	0.5	0.5	0	1.25	1.36	42.21	357.70	4
OT	0.2	0.8	0.2	2.38	2.30	1.39	4.76	3
SOT	0	1	0	12.10	1.23	78.80	78.80	6

The first six columns in the above table report the weights and unconditional standard deviation for the six targeting cases discussed above. The seventh and the eighth columns report the minimized loss, and the relative ranking in terms of loss each rule imply. The losses are evaluated at the weights for flexible inflation targeting.

The quantitative results corroborate the graphic analysis. In particular, the top performing rule is the FIT one, while the performances of the SOT and the SIT represent the worst cases. It follows that for intermediate weights on inflation stabilization and output-gap stabilization, and interest rate smoothing, the corresponding combination of inflation and output-gap volatility will be lower than the volatility implied by the rule representing the ECB strategy, i.e. the SIT one.

The analysis suggests that a monetary strategy that only targets price stability, like the ECB one, is inferior with respect to a strategy that encompasses different targets such as output gap stability and financial stability.

2.2 A Forward Looking Rule

In analysing the targeting rule we have stressed that, in the case of a purely backward-looking linear model with a quadratic loss function, certainty-equivalence applies. The only difference with the full information case is that the optimal policy is not calculated on the actual value of the state vector: the reaction function responds to an efficient estimation of the state variables13. In the monetary policy literature there has been a deep debate on the information set the central banks should use to fix the interest rate. More precisely, the discussion has focused on the possibility and the relevance for the monetary authority to include some forward-looking variables in the reaction function specification14. Nevertheless, many economists are sceptical about the improvement that can be obtained from the inclusion of a forward-looking variable in a macroeconomic model for monetary policy and, in any cases, they stress the need to incorporate a sort of history-dependence in a rule to be considered as optimal15.

In the following an example of forward-looking monetary rule is presented. The Generalized Methods of Moments (GMM) is the econometric approach used to conduct estimation in a context of intertemporal optimization-Rational expectation framework16. Following the work of Clarida et al. (1998) the empirical model specified for the GMM estimation of the monetary rule is:

$$\tilde{i}_t = \bar{i} + \beta\left(E\left[\pi_{t+n}\middle|\Omega_t\right] - \pi^*\right) + \gamma\left(E\left[y_t\middle|\Omega_t\right] - y^*\right) \quad [7]$$

Moreover, to take into account the tendency of Central Banks to smooth interest rates a partial adjustment mechanism is introduced as follow:

$$i_t = (1-\rho)\tilde{i}_t - \rho i_{t-1} + v_t \quad [8]$$

---

[13] See Svensson and Woodford (2000).

[14] The need of a forward-looking dimension in monetary policymaking has been stressed by several authors, among others Batini-Haldane (1998) and Svensson-Woodford (2000), as a necessary condition for a better representation of the central banks' behavior.

[15] See Woodford (2000) on this point. This scepticism is based on the consideration that by allowing a central bank to react to forecasts of the future inflation we are not eliminating the backward-looking component in the central bank behaviour: as the forward-looking components are recovered from current and lagged data of the related variables they are in fact backward-looking. The main advantage of forward-looking rule is then the inclusion of other variables besides output gap and inflation that can help to forecast monetary actions.

[16] This method, developed by Hansen (1982) and initially used in the consumption theory for the estimation of the Euler equation, has recently been employed by several authors to estimate the central banks' reaction function.

where $\tilde{i}_t$ is the target interest rate, $\bar{i}$ is the long-term equilibrium nominal interest rate, y_t is the real industrial production, π_{t+n} is the inflation rate between the periods t and t+n, π^* and y^* are the equilibrium values for inflation and output17 respectively. Finally, E denotes expectation formed conditionally upon the information set, Ω, available at time t.

The monetary rule emerging from equation [7] and [8] underlines the central bank capability of having direct information about the current value of both output and inflation when is setting the target interest rate. Another important feature of the above monetary rule is the inclusion of the expected inflation in the reaction function: this characteristic may be useful in trying to disentangle the connection between the estimated coefficient and the central bank objectives.

The results are shown in Figure 4 and Table 2.

In the estimated model, the interest rate response coefficient on the inflation rate, i.e. β, is above the stability threshold of one. This evidence, stressed by Taylor (1998), is a crucial feature for having a dynamically stable monetary policy. In his paper, Taylor gives also a theoretical basis for this result. Essentially, he argues that having a response coefficient lower than one, resulted in a positively sloped aggregate demand curve, cause the output to decrease in response to an inflation shock, which is destabilizing.

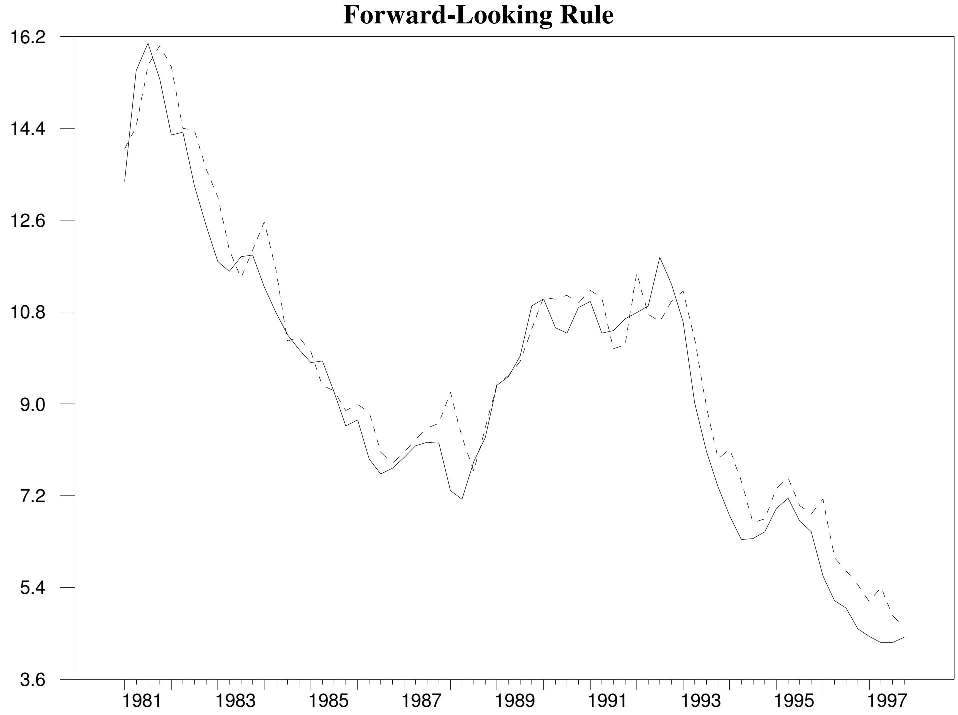
Table 2: Estimated Coefficients of Forward-looking rule

	Coefficient	Standard Error
ρ	0.706	0.11
α	4.660	0.8
β	1,706	0.36
γ	0.188	0.07
χ^2	0.846	

Note: The χ^2 row refers to the p-values for the J statistic used to test the overidentifying restrictions. The instruments are 1, four lags of interest rate, four lags of inflation rate, four lags of money growth, four lags of real effective exchange rate and four lags of output gap. Estimates are obtained by GMM with correction for MA(4) autocorrelation.

[17] For a comparison purposes we do not use a quadratic trend to derive the output gap as done in Clarida-Gali-Gertler(1998): as in deriving the optimal feedback rule, the potential output is calculated, instead, using the Hodrick and Prescott filter with a penalty parameter set to 1600.

Figure 4: Estimated Rules (solid line) vs. Actual Interest Rate (dashed line)



From Table 2 we can see that a rise in expected inflation produces a large response of central bank in terms of real interest rate reaction: an increase of one percent induces the monetary authorities to raise the real rates by 70 basis point.

Another interesting result regard the output gap estimated coefficients, i.e. γ: a rise in the output gap induces central banks to increase interest rates. A one percent increase in output gap induces the central bank to increase nominal (and thus real) rates by 18 basis point. We can conclude that over the sample period the central banks of the EMU countries have responded to inflationary pressures by increasing the real rates and have attached a low weight to real economy pressures18.

The estimated coefficients are used to assess the relative degree of severity of European monetary stance in comparison with the reaction function of Bundesbank and FED. In particular, we estimated, over the same sample period, the forward-looking rule for Deutsche Bundesbank (BUBA) and U.S. Federal Reserve (FED). Then we compare the recovered response coefficients with those obtained for the ECB. The response coefficients of the reaction functions are likely to be different. This is because the ECB's brief set out in the 1992 Maastricht Treaty is to keep inflation in the range 0-2 per cent. In this it differs both from the US Federal Reserve (FED) which is charged

[18] The idea that European aggregate demand is sensitive to interest rate movements is widely accepted. According to a recent study carried on balance sheet and profit and loss account data for seventeen different European industries, Mojon et al. (2001) find that a change in the user cost of capital, which in turn is affected by interest rates, has both statistically and economically significant effect on investment in the euro area. A similar conclusion is provided by the Europan Economy (2001) where profitability, relative investment prices and real interest rate seem to have a strong relationship with the investments evolution.

with finding a trade off between the goals of combating inflation and maintaining employment as well as from the BUBA (Bundesbank). The latter, although unconstrained by any full-employment goal, adopted so-called inflation targeting. Furthermore, the FED can in principle use more active fiscal policy to offset any weakness on the monetary side. Table 3 synthesizes the results.

Table 3: Comparison between Estimated Coefficients

	β	γ
ECB	1,706	0.188
	[0.36]	[0.08]
Bundesbank	1.3	0.2
	[0.24]	[0.09]
Federal Reserv	1.1	0.9
	[1.18]	[008]

The aim is to compare the weight that the three central banks assign to output gap and inflation. According to the estimated rules, BUBA and FED are less reactive to a rise in expected inflation. The coefficient on inflation are both lower than the ones obtained for ECB. In particular, the above table indicates that ECB has the highest response coefficient for expected inflation: an increase of one percent in expected inflation induces US and German monetary authorities to raise real rates by 10 and 30 basis points respectively.

Concerning the output gap response coefficients, i.e. γ, the FED has the strongest reaction to an increase in output gap. The response of the ECB is the lowest. A one percent increase in output gap induces the Bundesbank and FED to raise nominal (and thus real) rates by 20 and 90 basis points respectively. In line with previous studies, those results suggest that the FED and the Bundesbank are more concerned about output gap movements. We can conclude that over the sample period, the ECB had the strongest inflation reaction and the lowest output gap response.

3. An Evaluation of Fiscal Policy Deflationary Bias

We now turn to the analysis of fiscal policy currently carried on in EMU. The approach we follow is similar to the one used in evaluating the monetary policy. The starting point is that the fiscal policy envisaged firstly by the Maastricht Treaty and later by the Stability Pact aims at realizing financial stability. This stability implies the reduction of public debt stock liabilities and the decrease in the share of public component of aggregate demand. Our interpretative hypothesis is that such a policy could, in principle, generate a deflationary bias. It is not worthless to mention this possibility is not widely accepted: from a theoretical point of view, in fact, the potential recessive effect coming from an orthodox fiscal policy is refused by the authors emphasizing the so-called "non Keynesian effects of Keynesian policies"19. According

[19] On this point a different conclusion is reached by Faust et al. (2001), whose results suggest that the ECB reaction function features a high weight on the output gap relative to the weigh on inflation compared to the Bundesbank.

to this position a contractionary fiscal policy could have an unexpected expansionary effect if agents associate an increase in their own wealth to such a policy20.

Is not our aim to discuss about the theoretical plausibility of this position; we focus, instead, on the specific results of this policy in the European case during the Nineties. The advocates of financial stability in EMU refer to the general content of non Keynesian effect of Keynesian policy but, in the specific European case, they stress the importance of three elements.

The first one focuses on the possibility of bailout the ECB could face if banks and financial institutions hold a high share of public bonds issued by a government prone to fiscal laxity. In such a case the private banks could afford a problem of capital losses and hence need a bailing out by central bank. But, as the ECB has not an institutional commitment to behave as a lender of last resort, the bailout must, by definition, be avoided21. The second element emphasizes that the central bank degree of independence is thought to be closely linked to the constraints on public deficit. Those constrained are considered the best tool to achieve monetary independence from political pressures. Finally, the third element stresses that an excessive issue of public debt bonds could originate pressures on interest rate term structure, and hence a crowding out effect.

Following the aforementioned guidelines, a structural break in fiscal behaviour of EMU member states can be observed in the last decade. Specifically, this break, widely accepted in the EMU literature, can be summarized in the following features22:

i) The fiscal consolidation starting in Europe in the first years of last decade could not be endogenously explained by the historical reaction function of national fiscal authorities23.

ii) As a consequence of consolidation, fiscal policy became, in each country, less responsive to business cycle.

iii) Finally, this break arises a phenomenon of monetary dominance, according to which the decision of national central banks on interest rates and monetary aggregates are not constrained by public debt dynamics.

While this structural change is commonly accepted, there is a more cautious position about the existence of a deflationary bias leading from such a policy. On this point there are two different standpoints: a first one stresses the neutrality of public debt and deficit dynamics on aggregate demand. A second one stresses the existence of a resulting recessive bias24. However, a general evaluation of this phenomenon for the EMU as a whole focusing on the nineties is hardly to be recovered in the existing literature25.

---

[20] Giavazzi and Pagano (1990) pioneered a revaluation of the effects generated by reducing public deficit.
[21] This idea arose examining the fiscal policy stabilization experiences followed during the eighties in Denmark and Ireland.
[22] We refer to the notion of independence developed in Alesina- Summers (1993).
[23] These features are deeply examined in von Hagen et al. (2001).
[24] According to von Hagen et al. (2001) this evidence holds for eight out of eleven EMU countries.
[25] See Wiplosz and Eichengreen (1998). Further, van Aarle and Garretsen (2001) reach the conclusion that there is no a clear cut evidence for the hypothesis of "expansionary fiscal contractions" following to fiscal consolidation in the EMU case. The overall effect of fiscal adjustment on private spending appears to have been relatively small. However, this conclusion is biased because they only focus on the consumers' reaction, neglecting the firms' behaviour.

The starting point of our quantitative analysis lies on the need of focusing on the likely effects the Maastricht Treaty have caused on the EMU real economy. More precisely, we estimated the effects on output gap of fiscal stance for the period 1991-1998. The proxy used as measure of fiscal stance is the primary surplus divided by potential output. This choice is supported by several considerations. First of all, using the primary rather than the total surplus we avoid any problem of spurious relationship that the inclusion of interest payments might create between monetary and fiscal policy. Second, as fiscal authorities have more control over the ratio of the primary surplus to potential output than they do over the ratio of this surplus to current output, the selected measures of fiscal stance better reflects the official behaviour.

The structural equation has been estimated by using the two-stage-least-squares (2SLS) technique. The instrumental variables methodology allows to solve the problem of contemporaneous correlation between output gap and primary surplus GDP ratio by choosing a set of instruments correlated with the endogenous explanatory variables but uncorrelated with the regression disturbances. The data are quarterly and refer to the above mentioned synthetic economic indicators constructed by ECB.

The estimated equation is (standard errors of coefficients in square brackets):

	y_t	y_{t-1}	ΔPS_t
y_{t+1}	0.87	-0.04	-1.03
	[0.07]	[0.02]	[0.35]

R^2=0.85, SEE=0.3, DW=2.05

Heteroscedasticity (ARCH 1 Test, $\chi 2(1)$: 0.747 [0.387]

Normality (Hansen- Test): 1.184 [0.553]

Stability (Joint Statistic): 1.03 (critical value: 1.24)

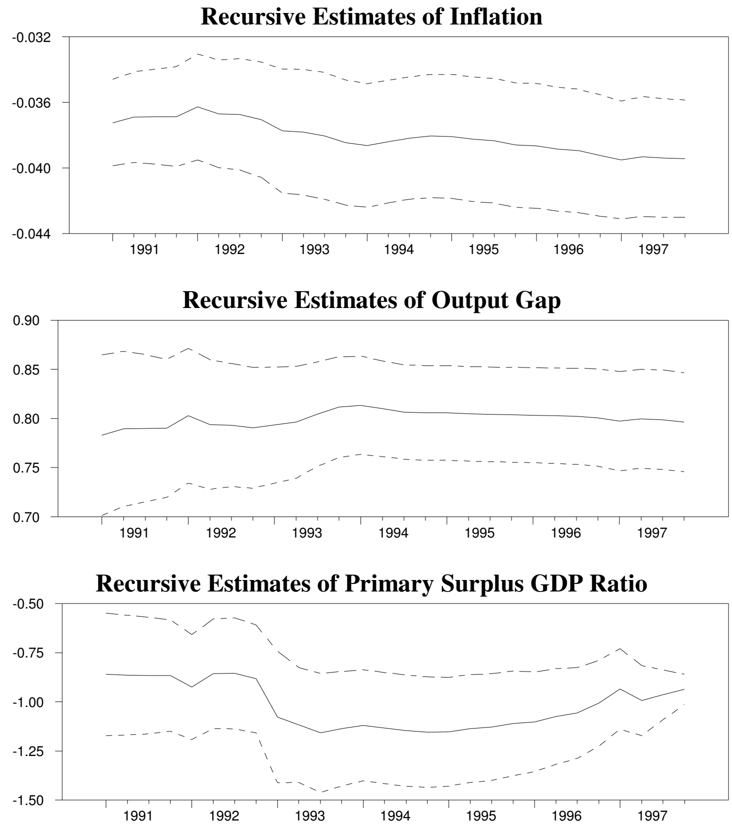
Autocorrelation (Ljung-Box Q-Statistic): 25.08 [0.198]

where y_t and π_t have the usual meaning; ΔPS_t is the change in the primary surplus - GDP ratio at annual rate and.

Consistently with our interpretative hypothesis, the above equation shows that an increase in primary surplus - GDP ratio year-to-year change of 1% decrease output gap by almost 100 within a year.

Moreover, to give a sense whether the coefficients seem constant over the sample they are estimated recursively adding one period to the end of the estimation range, keeping the starting date fixed. Figure 5 graphs recursive coefficient estimates along with 1.96 standard error bands around them. The figure shows that the estimated coefficients are not grossly incorrect. In fact, as zero is not contained within the -1.96 and +1.96 standard error bands at any time over the entire sample period it means that one would not fail to reject a zero coefficient on the estimated variables using the selected sample. The figure also underlines the recessive effects resulting from the Maastricht Treaty. From the 1992 onward we observe a decrease in the fiscal stance coefficient. From the beginning of Nineties to the period following the Maastricht Treaty the output gap reaction to a 1% contractionary fiscal policy change moves from -75 basis points to more than -100 basis points. This evidence is consistent with a bigger recessionary effect of a fiscal policy tight resulted from the commitments imposed by Maastricht Treaty. All in all, our estimates, carried on for the 90s on the Euro Area as a whole, indicate the existence of an uncontroversial deflationary bias that further validates previous studies.

Figure 5: Recursive Estimates



4. An Evaluation of Overall Economic Policy Deflationary Bias

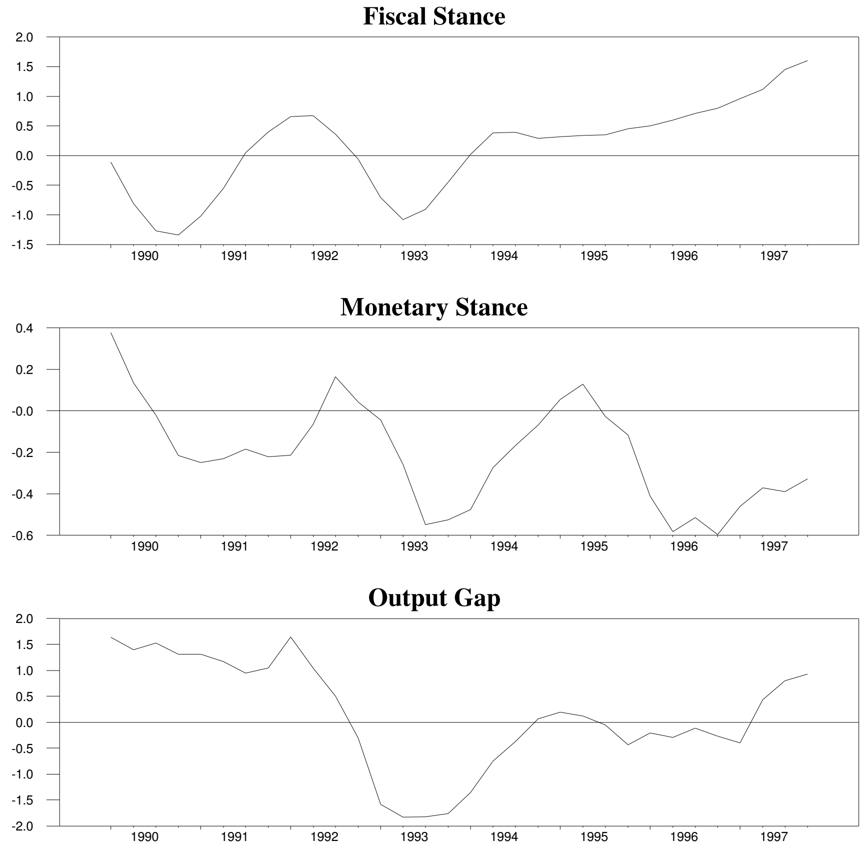
Once a deflationary bias implied by fiscal policy and monetary policy has been separately analysed, it is relevant to consider simultaneously the behaviour of the overall economic policy in the euro area. In principle, the existence of an overall bias has not to be taken for granted because a fine tuning policy can be conducted with a consistency between monetary and fiscal policy; for example, an economic policy strategy may consist in easing monetary policy as long as fiscal policy is characterized by lower public deficit and debt[26]. The monetary and fiscal stances during the Nineties are depicted in Figure 6.

The proxy used as a measure of fiscal stance is the change in the primary surplus - GDP ratio at annual rate. The monetary stance, as in Christiano et al. (1998), is recovered by the four quarter moving average of the interest rate shock in equation [8], i.e. $\left(v_t^i + v_{t+1}^i + v_{t+2}^i + v_{t+3}^i\right)/4$. In summarizing the results obtained in the analysis, is

[26] For example, the most representative research of this literature, the Wiplosz and Eichengreen one, refers to single countries evidence, France, Germany, Italy and UK. The Euro Zone is not considered as a whole; the sample period covers two decades, from the mid seventies to the mid of eighties; hence, the deflationary bias following to the Maastricht Treaty are not specifically evaluated.

useful to interpret negative values of the policy stance as monetary and fiscal tight, while positive values as a loose monetary and fiscal policy. According to the selected measure of policy stance, monetary and fiscal policies were both contractionary during the recession of the early Nineties. Figure 6 shows that European economy did not experience the above mentioned policy consistency between monetary and fiscal policy because the fiscal consolidation followed by Maastricht Treaty has not been offset by an expansionary monetary strategy. This inconsistency resulted in a large output gap decrease.

Figure 6: Monetary and Fiscal Stance during the Nineties



In order to evaluate the existence of an overall economic policy deflationary bias we estimate the effect on output gap and inflation rate of both monetary and fiscal policy from the Maastricht Treaty to the birth of EMU. Hence, the sample period we consider in the estimation goes from 1991 to 1998. In the following analysis we assume the short term nominal interest rate as a proxy of the monetary instrument and the year to year change in the primary surplus GDP ratio as a proxy of fiscal stance27.

[27] This kind of consistency between fiscal and monetary policy can be observed in the USA experience during the nineties. See Council of Economic Advisors (2000).

The estimated equations are (standard errors of coefficients are given in parentheses):

	π_t	π_{t-1}	π_{t-2}	π_{t-3}	y_t	ΔPS_t
π_{t+1}	0.8	-0.16	0.12	-0.08	0.09	-0.07
	[0.19]	[0.10]	[0.20]	[0.01]	[0.07]	[0.05]

R^2 =0.9, SEE=1.12, DW=2.1

Heteroscedasticity (ARCH 1 Test, $\chi 2(1)$: 0.09 [0.75]

Normality (Hansen- Test): 0.45 [0.79]

Stability (Joint Statistic): 1.3 (critical value: 1.47)

Autocorrelation (Ljung-Box Q-Statistic): 17.47. [0.49]

	y_t	y_{t-1}	$i_t - \pi_t$	ΔPS_t
y_{t+1}	0.68	-0.09	-0.07	-0.46
	[0.09]	[0.01]	[0.01]	[0.10]

R^2 =0.86, SEE=0.3, DW=1.98

Heteroscedasticity (ARCH 1 Test, $\chi 2(1)$: 1.51 [0.21]

Normality (Hansen- Test): 4.14 [0.12]

Stability (Joint Statistic): 1.09 (critical value: 1.24)

Autocorrelation (Ljung-Box Q-Statistic): 5.62 [0.4]

The above equations show that monetary policy and fiscal policy exert a deflationary bias also if they are evaluated together. The coefficient for both policies are statistically significant and they confirm that while an increase in the year-to-year change of 1% of primary surplus GDP ratio lowers the output gap by almost 50 basis point within a year, the increase in the real interest rate of 100 basis point leads a fall in output gap of 7 basis point. Those results are consistent with the macroeconometric literature on the comparative effects on the aggregate demand of fiscal and monetary policy. The deflationary bias followed by this peculiar economic policy mix could have been thought as a necessary consequence, at least in the short run, to achieve price stability.

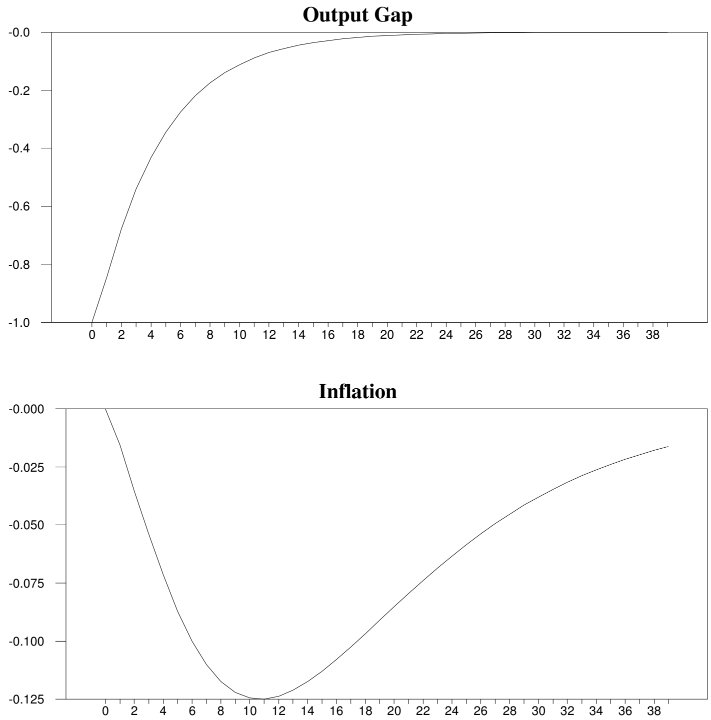
The rationale of this policy mix could be referred to the existence of an augmented Phillips curve with adaptive expectations. To this end, we can try as a final step to asses if deflationary bias has been, at least, effective in lowering medium inflation rate.

Starting from the estimated model is possible to compute an impulse response analysis in order to measure the time profile of the incremental effect of output gap innovation on the inflation dynamic.

The estimated response of inflation to a -1%, i.e. contractionary, output gap shocks is reported in Figure 7. A temporary decrease in output gap, i.e. an unanticipated deflationary shock, determines, initially, a huge impact of lowering inflation rate. Moreover, as output gap decrease dies out, inflation rate moves toward a long run negative value. But, this long run negative value in not quantitative great; hence, we can assume that sacrifice ratio, i.e. the effect of an increase in output gap on inflation rate, of such a policy must not have been relevant.

Figure 7 shows that a temporary decrease of aggregate demands that leads to an output gap reduction of 1% has a negligible effect on inflation rate: after forty quarters inflation rate lowers by almost 2.5 basis points.

Figure 7: Respose of Inflation Rate to a Negative Output Gap Shock (Quarters after shock)



5. Conclusion

The paper investigated whether the economic policy framework adopted by the EMU participating countries might create recessive tendencies. The first problem we considered was whether the institutional set-up provided by the Maastricht Treaty and implemented by the ECB ensures a solid foundation for maintaining price stability. The analysis attempts to analyze the performance of different rules capable of modelling how central banks of the EMU countries have made policy decisions affecting interest rates. Precisely, the monetary policy behaviour leading from Maastricht Treaty was studied by evaluating a backward- and a forward-looking monetary rule. A comparison between the actual and optimal policy rules gives rise to some important observations. First, the estimated rules suggest that the actual policy followed by the EMU members' central banks was looser than needed in the early and mid-1980s, while higher interest rates would have been advisable during the late 1980s and early 1990s. Moreover, since the establishment of the Maastricht Treaty nominal interest rates have been constantly higher than the rates implied by the estimated rules. The evidence is, hence, consistent with the hypothesis of a monetary policy that over-weighted the inflationary pressure. The study also focused on the efficiency of the estimated reaction function. The efficiency frontier for output-gap and inflation volatility suggests that a monetary strategy that only targets price stability, like the ECB one, is inferior with respect to a strategy that accounts for other targets such as output gap stability and interest rate smoothing. Moreover, the study carried on comparing the behaviour of European monetary policy with Deutsche Bundesbank and Federal Reserve one's, in the same sample period, suggested the existence of a more contractionary stance in euro area.

The study, then, turned on the main characteristics of the EMU member fiscal policy. We analysed the features of the European fiscal policy envisaged by the Maastricht Treaty and the Stability and Growth Pact. We computed a quantitative analysis on the likely effects Maastricht Treaty caused on the EMU real economy. The results indicated the existence of an uncontroversial deflationary bias.

The final step of the research consisted of considering simultaneously the behaviour of the overall economic policy in the euro area. In order to evaluate the existence of a general economic policy deflationary bias we estimated the effect on the output gap of both policies. Our results confirmed that the sacrifice ratio of these policies were negligible.

All in all, the evidence emerging from the estimated models suggest that the EU institutional set-up might create and/or amplify the recessive tendencies. The 2 per cent upper bound for inflation, the 3 per cent budget-deficit ceiling and the fiscal borrowing constraint (debt cannot exceed 60 per cent of GDP) were dreamt up in the late 1980s when the Community was still struggling with an inflationary legacy. The danger nowadays is not inflation but rather its opposite, deflation. As a consequence, the EU institutions need to be at least partially reformed.

References

Alesina A., Summer L. (1993), 'Central Bank Independence and Macroeconomic Performance', *Journal of Money, Credit and Banking*, **25**, 151-162.

Barro R.J., D.B. Gordon (1983), 'Rules, discretion, and reputation in a model of monetary policy', *Journal of Monetary Economics*, **12**, 101-121.

Batini N., A. Haldane (1999), 'Forward Looking Rule for Monetary Policy', *Bank of England Working Paper No.91*.

Bernanke B., A. Blinder (1997), 'The federal funds rate and the channel of monetary transmission', *American Economic Review*, **82**, 901-920.

Bank for International Settlements (2000), *70th Annual Report,* downloaded at <http://www.bis.org>.

Chadha J., Schellekens P.(1999), 'Monetary Policy Loss Function: two cheers for the quadratic', downlaoded at <http://www.bankofengland.co.uk/wplist.htm>.

Christiano L., Eichenbaum M., Evans C. (1998), 'Monetary Policy Shock: what have we learned and to what end?', *NBER Working Paper No.* 6400.

Clarida R., Gali J., Gertler M.(1998), 'Monetary Policy Rules in Practice: Some International Evidence', *European Economic Review*, 42, 1033-1067.

ECB (1998a), A Stability-Oriented Monetary Policy Strategy for the ESCB, downloaded at <http://www.ecb.int>.

ECB (1998b), The quantitative reference value for the monetary growth, downloaded at <http://www.ecb.int>.

Engle R. (1982), 'Autoregressive Conditional Heteroscedasticity with estimates of the Variances of United Kingdom Inflation', *Econometrica*, **55**, 251-276.

European Economy (2001), The EU Economy 2001 Review, n.73.

Fagan G., J. Henry J., Mestre R. (2001), 'An Area-Wide Model (AWM) for the Euro Area', *ECB Working Paper No.42*.

Faust J., Rogers J., Wright H. (2001), 'An empirical comparison of Bundesbank and ECB monetary policy rules', Board of Governors of the Federal Reserve System, *International Finance Discussion Papers No.705*

Fuhrer J. (1997), 'The (Un)Importance of Forward-Looking behaviour in Price Specifications', *Journal of Money Credit and Banking*, **29**, 338-350.

Gerlach S., Svensson L.E.O. (2001), 'Money and inflation in the Euro Area: a case for monetary indicators?', *BIS Working Paper No.* 98.

Giavazzi F., Pagano M. (1990), 'Can severe fiscal policy contraction be expansionary? Tales of two small European countries', *CEPR Discussion Paper No.* 417

Hansen L. (1982), 'Large Sample Properties of the Generalized Method of Moment Estimators', *Econometrica*, **50**, 1029-1053.

Hansen L. (1991), 'Parameter Instability in Linear Models', *Journal of Policy Modelling*, 14, 517-533.

IMF (1998), 'Economic Policy Challenges Facing the Euro Area and the External Implications of EMU', *World Economic Outlook*, downloaded at< http://www.imf.org>.

Kydland F.E., Prescott E.C. (1977), 'Rules rather than discretion: the inconsistency of optimal plans', *Journal of Political Economy*, **85**, 473-491.

McCallum B. (2000), 'The Present and Future of Monetary Policy', *NBER Working Paper No.* 7916.

Mojon B., Smets F., Vermeulen P. (2001), 'Investment and monetary policy in the Euro Area', *ECB Working Paper No. 78.*

Rudebusch G.D., Svensson, L.E.O. (1998), 'Policy Rules for Inflation Targeting', *IIES Seminar Paper No.637.*

Schmidt R. (1999), 'Differences between Financial Systems in European Countries: Consequences for EMU', mimeo.

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

Svensson L.E.O. (1998a), 'Inflation Targeting as a Monetary Policy Rule', *IIES Seminar Paper No. 646.*

Svensson L.E.O. (1998b), 'Open-Economy Inflation Targeting', *IIES Seminar Paper No. 638.*

Svensson L.E.O. (2000), 'The First Year of the Eurosystem: Inflation Targeting or not?', *NBER Working Paper No.7598.*

Svensson L.E.O., Woodford M. (2000), 'Indicator Variables for Optimal Policy', *NBER Working Paper No.7953.*

Taylor J. (1998), 'The Robustness and Efficiency of Monetary Policy Rules as Guidelines for Interest Rate Setting by the European Central Bank', *IIES Seminar Paper No. 649.*

van Aarle B., Garretsen E. (2001), 'Keynesian, Non-Keynesian or, no effects of fiscal policy changes? The EMU case', *CESifo Working Papers No. 570.*

von Hagen J., Hallet A.H., Strauch R. (2001), 'Budgetary Consolidation in EMU', *EC Economic Papers No.148.*

Wyplosz C. (2000), 'Do We Know How Low Should Inflation Be?', mimeo.

Wyplosz C., Eichengreen B. (1998), 'The Stability Pact: More Than a Minor Nuisance?', mimeo.

Woodford M. (2000), 'Pitfalls of Forward-looking Monetary Policy', *American Economic Review*, **90**, 100-104.

APPENDIX 1

The data used in the empirical part of the study are taken from the dataset used by Fagan et al.(2001) to construct the Area-Wide model for the euro area. We present the weight used in aggregating the individual country series.

Weights Used in Aggregation	
Austria	3.023
Belgium	3.9
Finland	1.699
France	21.003
Germany	30.529
Ireland	1.128
Italy	20.333
Luxembourg	0.233
Netherlands	5.585
Portugal	2.363
Spain	10.2331

APPENDIX 2

The State space representation of the estimated model is:

$$X_{t+1} = AX_t + Bi_t + v_{t+1}$$

This compact form is helpful in summarizing the structure underlined by the dynamic model. More precisely, in the above equation the $(k+h+3)\times 1$ vector[28] X contains the state variables, the $(k+h+3)\times(k+h+3)$ matrix A and the $(k+h+3)\times 1$ column vector B contains the estimated parameters, and the $(k+h+3)\times 1$ column vector v_t is the disturbance term. This representation summarizes the dynamic structure of the economy and the uncertainty that the central banks face regarding this structure. The matrix A and the vector B govern the dynamics of the state vector. Uncertainty enters through the additive stochastic vector v_{t+1}. The terms in equation [5] can be written as:

[28]Where h and k are the number of lags of the inflation and output equations respectively.

$$A=\begin{bmatrix} \sum_{i=1}^{h}\alpha_i e_i+\alpha_{h+1}e_{h+1} \\ e_1 \\ \vdots \\ \vdots \\ e_h \\ \beta_{k+1}e_{1:h}+\sum_{i=1}^{k}\beta_i e_i-\beta_{k+1}e_{(h+k+1):(h+k+2)} \\ e_{h+1} \\ \vdots \\ \vdots \\ e_{h+k} \\ e_0 \\ e_{h+k+1} \\ e_{h+k+2} \end{bmatrix}$$

where e_i denotes a $1\times(k+h+3)$ row vector with all element equal to zero and with the elements $i=1,\ldots\ldots k+h+2$ equal to unity; and where $e_{i:k}$ $(i<k)$ denotes $1\times(k+h+3)$ row vector with elements $i, i+1,\ldots.,k$ equal to $\frac{1}{4}$ and all other elements equal to zero. Notice that all variables entering in the state-space representation are expressed as a function of lagged data only. This condition comes from the particular model considered in the analysis which is, in fact, a backward-looking model[29].

$$X_t=\begin{bmatrix} \pi_t \\ \pi_{t-1} \\ \vdots \\ \vdots \\ \vdots \\ \pi_{t-h} \\ y_t \\ y_{t-1} \\ \vdots \\ \vdots \\ y_{t-k} \\ i_{t-1} \\ i_{t-2} \\ i_{t-3} \end{bmatrix},\quad B=\begin{bmatrix} 0 \\ 0 \\ \vdots \\ \vdots \\ \vdots \\ \vdots \\ -\frac{\beta_{k+1}}{4} \\ 0 \\ \vdots \\ \vdots \\ 0 \\ 1 \\ 0 \\ 0 \end{bmatrix}\quad \text{and} \quad v_t=\begin{bmatrix} u_t^{\pi} \\ 0 \\ \vdots \\ \vdots \\ \vdots \\ \vdots \\ u_t^{y} \\ 0 \\ \vdots \\ \vdots \\ \vdots \\ \vdots \\ \vdots \\ 0 \end{bmatrix}$$

[29]A forward-looking open economy model was used in Svensson (1998b). In this case, the state-space representation is much more complicated to derive.

Writing the target variables, π, y and i_t-i_{t-1} as a function of the state variable X_t we get:

$$Y_t = \begin{bmatrix} \bar{\pi}_t \\ y_t \\ i_t - i_{t-1} \end{bmatrix} = C_X X_t + C_i i_t, \text{ where } C_X = \begin{bmatrix} e_{1:h} \\ e_{h+1} \\ -e_{h+k+1} \end{bmatrix} \text{ and } C_i = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$$

The loss function can now be expressed as:

$$L_t = E\left[Y_t' K Y_t\right], \text{ where } K = \begin{bmatrix} \lambda & 0 & 0 \\ 0 & \varphi & 0 \\ 0 & 0 & \gamma \end{bmatrix}$$

The class of linear feedback rules considered here takes the following generic form:

$$i_t = fX_t$$

where f denotes a $1\times(k+h+3)$ vector. Using the foregoing relations, the dynamics of the model follows:

$$X_{t+1} = MX_t + v_{t+1}, \quad M = A + Bf$$

$$Y_t = CX_t, \quad C = C_X + C_i f$$

The optimal linear feedback rule is then supposed to be an interest rate rule that, given the economic structure implied by the rule, is able to minimize the central bank loss function. Thus, the optimal linear feedback rule can be expressed as:

$$f = -\left(R + B'VB\right)^{-1}\left(U' + B'VA\right) \quad X_t$$

where the matrix V satisfies the Riccati equation:

$$V = Q + Uf + f'U' + f'Rf + M'VM$$

and where:

$$Q = C_X' K C_X, \quad U = C_X' K C_i \text{ and } R = C_i' K C_i$$

In this case, the optimal value of equation [4] is given by:

$$E\left[L_t\right] = trace\left(V\Sigma_{vv}\right)$$

where Σ_{vv} is the covariance matrix of the disturbance vector. Different values of the state variable, X, different impact of monetary policy, A and B, and different central bank's preferences over inflation, output and interest rate smoothness, K, may result in a different interest rate policy, i.e. a different optimal linear feedback rule.

APPENDIX 3

Equation [7] is rearranged as:

$$\tilde{i}_t = \alpha + \beta E\left[\pi_{t+n} | \Omega_t\right] + \gamma E\left[\tilde{y}_t | \Omega_t\right] \qquad [A.3.1]$$

where $\alpha = \bar{i}_t - \beta\pi^*$ and $\tilde{y}_t \equiv y_t - y_t^*$. Taking into account the partial adjustment mechanism yields:

$$i_t = (1-\rho)\left\{\alpha + \beta E\left[\pi_{t+n} | \Omega_t\right] + \gamma E\left[\tilde{y}_t | \Omega_t\right]\right\} + \rho i_{t-1} + v_t \qquad [A.3.2]$$

Rewriting the last equation in terms of realized variables in order to eliminate the unobserved forecast variables we get:

$$i_t = (1-\rho)\alpha + (1-\rho)\beta\pi_{t+n} + (1-\rho)\gamma\tilde{y}_t + \rho i_{t-1} + v_t \qquad [A.3.3]$$

where the error term is now:

$$\varepsilon_t = -(1-\rho)\left\{\beta\left(\pi_{t+n} - E\left[\pi_{t+n} | \Omega_t\right]\right) + \gamma\left(\tilde{y}_t - E\left[\tilde{y}_t | \Omega_t\right]\right)\right\} + \rho i_{t-1} + v_t \qquad [A.3.4]$$

the set of orthogonality condition implied by equation [A.3.3] is:

$$E\left[i_t - (1-\rho)\alpha - (1-\rho)\beta\pi_{t+n} - (1-\rho)\gamma\tilde{y}_t - \rho i_{t-1} | u_t\right] = 0 \qquad [A.3.5]$$

where u_t includes all the variables in the Central Bank's information set at time interest rate is fixed.